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ABSTRACT

The document attempts to integrate aspects of two lines of research relating to picture recognition and the comprehension of pictorial space. It also describes an empirical study carried out in Nepal which tested rural adult subjects' understanding of topological, euclidean, and projective concepts in regard to real objects and to pictures. The document is divided into two parts. Part I explains the rationale for using pictures in nonformal educational settings and examines two approaches to picture perception (the constructive theory and the registration theory). It also discusses cross-cultural studies of intelligence and examines literature demonstrating that the intellectual demands of village life often do not stimulate higher cognitive processes as identified by Piaget. Part II details the Nepal study which used four samples of adult subjects at various educational levels. Sixteen experiments tested the recognition of depicted objects, the understanding of spatial relationships in concrete situations, and the comprehension of pictorial space. Findings showed the recognition of familiar objects to be easier than the comprehension of pictorial space, a poor understanding of euclidean and projective relationships by the villagers but a higher performance by the furniture workers and engineering students, and an easy grasp of topological relationships in pictures by all the subjects. Conclusions are that the interpretation of pictorial space is an active process which calls for conscious awareness of projective principles, and that the use of pictures where important meaning is carried by projective cues should be avoided. Two teaching strategies are recommended for use in nonformal educational settings. (Author/CK)

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UNDERSTANDING PICTURES:
A STUDY IN THE DESIGN OF APPROPRIATE VISUAL MATERIALS FOR EDUCATION IN DEVELOPING COUNTRIES

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SO 012 528

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FOREWARD

To date, the emphasis in nonformal education has been on adapting methods and content to the needs and capabilities of learners in non-school settings. While much has been accomplished in the area of methods, very little attention has been given to problems associated with the use of pictures and other ivsuals in nonformal education. Posters, photographs, line drawings and schematic diagrams are often taken directly from school settings to nonformal education activities with no change. Only recently has attention been paid to the concept of "visual literacy" and serious efforts made to understand the learning process which leads to the capability to interpret visual materials.

Understanding Pictures is a pioneering work which builds a bridge between the theoretical literature of perceptual psychology and the cognitive learning theorists on the one hand, and the realities of villagers' ability to understand pictures in rural Nepal on the other hand. Previous research has focussed either on describing the cognitive and perceptual abilities of villagers, or has described in a pragmatic way what kinds of visuals villagers seem to understand best. The two efforts have at best been vaguely linked. Practitioners in the field have had to content themselves with some simple rules of thumb, or more often had to proceed with whatever visuals were available and hope for the best.

Most of the existing attempts to link the theoretical and the practical have focussed on the learning of the graphic conventions of pictorial representation. Visual cues of perspective, foreshortening, and overlap of images to portray three dimensional reality have been studied in field settings. There is general agreement that these are learned abilities which need both the opportunity and systematic effort to develop in unschooled populations. On the other hand, the extensive body of research on Piagetian concept development contains little evidence linking these abilities to the task of understanding pictures. This study makes significant progress in suggesting likely linkages between the development of spatial concepts and the kinds of pictorial representation which will be correctly interpreted.

The study confirms earlier findings that villagers will be unable to understand the graphic conventions unless they have been exposed to certain kinds of learning opportunities. The author then explores the relationship between villagers' development of spatial concepts and their ability to "read" visuals. He produces some provocative new insights which suggest that villagers have a good intuitive understanding of topological concepts and can generally interpret pictures which rely on aspects such as sequence, continuity, separation, and enclosure to convey the message. However, pictures which rely upon higher order spatial concepts of euclidean space and projection are generally not understood, unless villagers have developed those concepts.

By linking the development of cognitive skills in spatial perception to the understanding of pictures, the author provides a tantalizing framework upon which a theory of pictorial understanding might be built. For the first time there appears to be a possibility that theory could be used to predict how visuals are likely to be interpreted by unschooled viewers. With such a theory, more systematic experimental field testing becomes possible and ultimately the practitioner may have some clear guidelines to use in producing visuals for use with learners in nonformal educational settings. The final section of the study takes several health education visuals and analyzes the way in which their message is likely to be perceived. The study does not test these hypotheses, but lays solid groundwork for field research to test them in the future.

The study combines a clear overview of the very extensive psychological research with readable presentations of the field work carried out in Nepal. To the reader unfamiliar with the issues underlying the discussion on "visual literacy" this study will be a substantial asset. To the more informed professional working either in cognitive psychology or in the design of effective visual learning materials, the study provides a most hopeful glimmer of a theoretical framework for future work in the development of our knowledge on how people learn to understand pictures. Even at the present preliminary stage of development, the ideas presented in this study will prove of practical value to practitioners of nonformal education who cannot wait for further research.

David R. Evans
Amherst, Massachusetts
September, 1979

AUTHOR'S PREFACE

Visual materials in the form of posters, flip charts, flash cards, filmstrips and so forth are being used throughout the developing world for educational purposes. Furthermore, their usefulness appears to be greatest in those areas where literacy skills are low. But only recently have psychologists and educators begun to investigate some of the difficulties that unacculturated village people encounter when confronted with pictorial information.

Reading and writing have traditionally been associated with formal schooling, whereas understanding pictures seems to come quite spontaneously. It is hard for someone growing up in the West to remember a period in childhood when pictures were difficult to comprehend, much as it is hard for us to remember a time when we did not have the use of language. This difficulty masks, however, the important fact that understanding pictures is not as spontaneous as it might appear and in fact involves a great many learned abilities. This is demonstrated when we investigate more closely what people who have had little exposure to graphic representations see when they look at pictures.

Western trained educators preparing illustrations for use in the developing world make many assumptions about what can be communicated through pictures. The challenge is to find out to what degree those assumptions are valid. Over the last two decades, beginning with Hudson's studies of pictorial depth perception in Africa, a few isolated efforts have investigated some of these assumptions. The studies have centered on questions of picture recognition, and, in a few cases, on the comprehension of pictorial space.

At the same time a host of cross-cultural psychologists have been investigating a broad range of closely related questions. Their studies, many of them applying Piaget's theory of cognitive development to other cultural settings, have attempted to investigate the question: to what degree does the low level of intellectual stimulation typical of many traditional village settings result in a failure of certain cognitive abilities to develop to their fullest potential? Many of these studies have centered around the question of conservation, but a number of other aspects of cognition have also been investigated.

In addition to perceptual skills, a great many cognitive skills, and especially those commonly identified as spatial abilities, are involved in getting meaning from pictures. A further question, therefore, needs to be raised about assumptions we might make regarding pictorial communication. Over and above those difficulties that may stem from the need to learn specific graphic conventions, what aspects of picture comprehension also require more general cognitive structures, especially those relating to spatial concepts? Presumably, if a person has difficulty handling spatial concepts in the real world, those difficulties will be transferred and perhaps compounded when encountered in pictures.

The present study addresses a number of questions related to picture recognition and the comprehension of pictorial space. It attempts to integrate aspects of the two lines of research described above--one line having to do with learned abilities that pertain specifically to pictures and the other dealing with a more generalized understanding of spatial relationships and their application to pictorial space. The first three chapters, comprising Part I, will explore the larger issues of visual communication, picture perception and the nature of intelligence as they relate to traditional societies. This discussion will form the theoretical background for an empirical study which will be the subject of Part II.

The empirical study was carried out in the summer and fall of 1978 in Nepal, using largely unschooled, rural adult subjects. Interviews were based on a series of sixteen tests, some of them derived directly from Piaget's work on the development of spatial concepts, some adapted from previous research on graphic conventions carried out in Nepal and other developing countries, and some entirely new tests developed by the author. Specifically, the tests investigated the subjects' understanding of topological, euclidean and projective concepts, both with regard to real objects and to pictures. It is hoped that the findings of this research, in addition to exploring some of the important theoretical questions of education and psychology, will be of value to practitioners in the field of nonformal education who are designing visual materials for use in developing countries.

ABSTRACT

Understanding Pictures: A Study in the Design of Appropriate Visual Materials for Education in Developing Countries

The human resources approach to national development has challenged educators to find ways of communicating with village people that do not rely on the written word. Pictures are being used increasingly as a way to deliver messages to illiterate groups. Recent cross-cultural research has shown, however, that many of the assumptions made about the kinds of information that can be delivered through pictures needs to be re-examined.

Part I of the study sets forth the rationale for using pictures in nonformal educational settings and examines two current approaches to the problem of picture perception. The "constructive" theory maintains that pictures are inherently ambiguous and require active interpretation on the part of the viewer. The "registration" theory suggests that pictures give information which derives from the ecology of light. In this view the recognition of graphic depictions is considered to be a fairly passive matter and a gift allowed us by the environment. The evidence of cross-cultural research in picture perception which gives support to each of these positions is reviewed.

Part I also discusses cross-cultural studies of intelligence and examines a body of literature which demonstrates that the intellectual

demands of village life are often such that they do not stimulate some of the higher cognitive processes identified by Piaget. The author takes the position advanced by Piaget and Vygotsky that the development of conceptual awareness advances from an intuitive level to one of conscious understanding. Bruner's thesis concerning three modes of learning is also discussed. The traditional modes of learning in village settings are enactive (learning by doing) and iconic (learning by modeling). Symbolic learning, which is learning by being told, usually takes place out of the context of ongoing action and, as such, is a radical departure from traditional practice. Like written language, pictures provide a form of symbolically coded experience, and in many cases the learner must be consciously aware of the cues of pictorial expression and how they are used, in order to properly decode their meaning.

Part II details an empirical study carried out in Nepal with four samples of adult subjects: villagers with no schooling, villagers with some primary or secondary schooling, workers in a furniture factory in the capital city of Kathmandu, and students at Tribhuvan University's Institute of Engineering. A series of sixteen experiments was carried out. The abilities tested were the recognition of depicted objects, the understanding of spatial relationships in concrete situations, and the comprehension of pictorial space. In an effort to avoid introducing arbitrary graphic conventions, photographs and line drawings based on photographs were primarily used as the pictorial stimuli. The recognition of familiar objects in pictures was found to be a great deal easier than the comprehension of pictorial space. The village samples showed a generally poor understanding of euclidean and projective relationships both with regard to real objects and in interpreting pictures. The furniture factory workers and the engineering students performed at higher levels on all experiments, showing that environmental influences or specific experiences of some kind are important both in the development of spatial abilities and in the understanding of pictorial space. On the other hand, topological relationships in pictures were easily grasped by almost all of the villagers.

The author concludes that perspective information was understood at only an intuitive level by the majority of the villagers tested and could not be consciously applied to the interpretation of spatial relationships in pictures. Projective information was consistently interpreted topologically by most of the village subjects. The author suggests that the recognition of familiar objects in pictures is largely an ability which does not require special learning, but that the interpretation of pictorial space is an active process which calls for conscious awareness of projective principles. Recommendations for the design of visual materials for use in nonformal educational settings are made.

TABLE OF CONTENTS

Page

FOREWARD v

AUTHOR'S PREFACE ix

ABSTRACT xiii

LIST OF TABLES xxi

LIST OF FIGURES xxiii

PART I

Chapter
I. PICTURES AS A MEDIUM OF COMMUNICATION 3

- Using Visual Aids in Development Work 3
  - An instance of learning through pictures 10
- Visual Communication 12
  - Current theories of perception 13
  - Picture perception 18
- The Language of Pictures 26

II. CROSS-CULTURAL STUDIES IN PICTURE PERCEPTION 41

- The Study of Visual Illusions 42
  - The "carpentered-world" hypothesis 44
- Understanding Representational Material 51
  - Pictorial regognition 53
  - The comprehension of pictorial space 61
  - Thinking with the language of pictures 68
- Reasons for Cross-Cultural Differences 72
  - Cultural stimulation, schooling and intelligence . . . 73
  - Socialization practices 74
- Teaching Experiments and Applied Research 82

Chapter Page

III. THE NATURE OF INTELLIGENCE AND SOME IMPLICATIONS FOR DEVELOPMENT EDUCATION 87

Current Theories of Intelligence 88
  The evolution of the idea of intelligence 89
  Developmental approaches 93
Cross-Cultural Investigations 98
  Classification studies 99
  Conservation studies 104
Factors Influencing Cognitive Growth 108
  Schooling 110
  Environmental Stimulation 114
Implications for Education 119
  Enactive, iconic and symbolic modes of learning 122
  Strategies for nonformal education 126

PART II

IV. PROBLEMS OF PICTURE RECOGNITION 133

Background of the Study 134
  Subjects 136
  Method 145
Identifying Depicted Objects 149
  Experiment 1: identifying photographs 150
  Experiment 2: matching pictures to models of animals . 175
  Experiment 3: counting cubes and making simple constructions 187

V. UNDERSTANDING PICTURE SPACE 215

Topological Space 217
  Experiment 4: drawing geometrical shapes 219
  Experiment 5: action based on topological cues 240
  Experiment 6: distinguishing true and false knots . . . 243
  Experiment 7: arranging a series of pictures in sequence 247
Euclidean Space 252
  Experiment 8: frames of reference 253
  Experiment 9: reproducing a layout 265
  Experiment 10: depicted placement and orientation . . . 266
Projective Space 271
  Experiment 11: perspective views of a pencil and a coin 273
  Experiment 12: drawing a cube 283
  Experiment 13: arranging cubes as shown in pictures . . 288
  Experiment 14: foreshortening 298
  Experiment 15: perceiving depth in pictures 301
  Experiment 16: coordinating perspectives 319

Chapter Page
VI. SUMMARY AND CONCLUSIONS 331

Picture Recognition 332
The Development of Spatial Abilities 338
Understanding Pictorial Space 341
Limitations of the Study 347
Designing Visuals for Use in Villages 349

. . . .

BIBLIOGRAPHY 361

APPENDIX 369

LIST OF TABLES

Table Page
1. Percentage of Correct Identifications of Familiar Objects Depicted in Six Representational Styles 56
2. Factors Mentioned in the Cross-Cultural Literature as Having Influence on Picture Perception 82
3. Instructional Technologies Used in Connection with Bruner's Three Modes of Knowing 124
4. Age Range of the Village Sample 137
6. Level of Schooling Attained by Members of the Village Sample 140
7. Educational Status of the Village Sample 142
8. Number of Respondents in Each Village of the Study 149
9. Erroneous Counts of the Number of Chicks in Figure 30 . . . 162
10. Incorrect Responses to Figure 32 165
11. Incorrect Responses to Figure 33 167
12. Incorrect Responses to Figure 34 168
13. Scores and Percentile Ranking on Matching Pictures to Models of Animals 184
16. Educational Status of Subjects Making Errors in Distinguishing Knots 245
17. Number of Subjects Designating Various Sequences for Stages of Gathering Wood 249
18. Frames of Reference: Quantitative Findings 251
19. Perspective Views of a Pencil and a Coin: Quantitative Findings 280
20. Arranging Cubes as Shown in Pictures: Percentage of Correct Responses on Each Picture by Subsample and by Total Sample 294
21. Foreshortening: Erroneous Responses to Figure 118 300
22. Responses to Figure 121 309
23. Responses to Figure 122 311
24. Responses to Figure 123 313
25. Performance of Nine Engineering Students on Test of Coordinating Perspectives 326

LIST OF FIGURES

Figure

1. Poster in Nepali Showing How to Build a Pit Latrine 8
2. Two Degrees of Pictorial Abstraction: (a) Blueprint Diagram, (b) Circuit Diagram 9
3. A Recognizable Object Having Arbitrary Meaning 9
4. Diagram of the Ames Room 19
5. Drawing of the Appearance of the Ames Room 20
6. A Line Depicting an Occluding Bound 24
7. Devil's Tuning Fork: An Example of an Impossible Object . . 30
8. Figure-Ground Reversal 34
9. Looking Down on a Cube 35
10. The Necker Cube 36
11. The Sander Parallelogram 45
12. The Muller-Lyer Illusion 45
13. The Horizontal-Vertical Illusion 46
14. The Ponzo Illusion 49
15. Outline Drawings such as This Were Identified by a Child with no Previous Exposure to Pictorial Art 53
16. An Example of a Three Tone Drawing 56
17. One of Hudson's Outline Drawings 57
18. A Series of Pictures Used by Hudson to Investigate Depth Perception in Pictures 62
19. Page from a First Grade Primer Used for Test of Literacy . 141
20. Picture 1: Baby 151
21. Picture 2: Buffalo Calf 152
22. Picture 3: Bananas 153
23. Picture 4: Making a Basket 154
24. Picture 5: Woman Sifting 155
25. Picture 6: Peppers 156
26. Picture 7: Flying a Kite 157
27. Picture 8: House 158
28. Picture 9: Hoe 159
29. Picture 10: Water Buffalo 160
30. Picture 11: Baby Chicks 161
31. Picture 12: Tea 163
32. Picture 13: Plate 165
33. Picture 14: Corn 166
34. Picture 15: Blacksmith 167
35. Identification of Photographs: Analysis of Errors per Picture and per Respondent 169
36. Identification of Photographs: Percentile Average According to Educational Status 172
37. Pictures Correctly Matched by All Respondents 178
38. Pictures on Which One Matching Error was Made 179

Figure

39. Pictures on Which Two Matching Errors Were Made 181
40. Drawing of a Bull 182
41. Cartoon Figure of a Sheep 183
42. Comparison of Percentile Scores on Identifying Photographs and Matching Pictures to Model Animals 185
43. Picture 1 189
44. Picture 2 189
45. Picture 3 190
46. Picture 4 191
47. Examples of a Construction Error Made in Response to Figure 45 191
48. Picture 5 192
49. Picture 6 192
50. Picture 7 193
51. Picture 8 194
52. Picture 9 194
53. Picture 10 195
54. Picture 11 195
55. Example of a Construction Error Made in Response to Figure 54 196
56. Picture 12 196
57. Picture 13 197
58. Picture 14 198
59. Picture 15 198
60. Picture 16 199
61. Picture 17 200
62. Picture 18 201
63. Picture 19 202
64. Picture 20 203
65. Percentage of Correct Answers per Subsample on Counting and Construction Test 206
66. Percentage of Items Correctly Identified in Experiments 1 and 3 by Village Subsamples 207
67. Topological and Euclidean Shapes 219
68. Topological Distinctions 222
69. The Discovery of Oblique Lines 222
70. The Discovery of Proportion 224
71. Mastering the Triangle 225
72. Diagonalized Figures 227
73. The Gradual Mastery of the Rhombus 228
74. A Circulscribed Figure, Substage IB 229
75. Circumscribed Figures, Substage IIA 230
76. Circumscribed Figures, Substage IIB 231
77. Circumscribed Figures, Stage III 232
78. Substage IB Protocol 233
79. Substage IIA Protocol 234
80. Substage IIIA Protocol 235
81. Copying Geometrical Shapes: Performance by Subsample . . . 238

18

Figure Page

82. Action Based on Topological Cues 241
83. True and False Knots 244
84. A Series of Pictures Depicting Various Stages of Gathering Firewood 248
85. Transitional Response Between Substages IB and IIA 256
86. Substage IIA 257
87. Substage IIB 258
88. Transitional Response Between Substages IIB and IIIA . . . 259
89. Stage III 260
90. Frames of Reference: Performance by Subsample 262
91. Picture Used to Test Understanding of Depicted Placement and Orientation 266
92. Correct Arrangement of Animals 268
93. Failure to Orient Line to Picture Plane 268
94. Failure to Render Either Relationship Correctly 269
95. Failure to Orient Animals to Each Other 269
96. Other Errors Made by Villagers 269
97. Other Errors Made by Engineering Students 270
98. Substage IIA Responses 275
99. Substage IIB Responses 276
100. Transitional Response Between Substages IIB and IIIA . . . 277
101. Substage IIIA Responses 278
102. Substage IIIB Responses 179
103. Perspective Views of a Pencil and a Coin: Performance by Subsample 281
104. Typical Drawing of a Cube 284
105. Drawings of a Cube by Village Respondents 285
106. Drawings of a Cube by Workers in a Furniture Factory . . . 286
107. Drawings of a Cube by Engineering Students 287
108. Picture 1 289
109. Picture 2 290
110. Picture 3 291
111. Picture 4 291
112. Picture 5 292
113. Picture 6 293
114. Picture 7 293
115. An Example of an Erroneous Response to Figure 114 294
116. The Three Basic Configurations of the Blocks without Perspective Cues 295
117. Topological Patterns of the Two Blocks with Perspective Details Removed 296
118. Pictures Used to Test Understanding of Foreshortening . . . 299
119. Examples from a Series of Pictures Used in Preliminary Experiments to Test Cues of Depth 303
120. Picture 1 306
121. Picture 2 307
122. Picture 3 310
123. Picture 4 312

Figure Page

124. Diagram Showing the Arrangement of the Three Models Made by the Majority of the Subjects Who Interpreted the Pictures in Depth 314
125. Picture A 320
126. Schematic Arrangement of the Models Showing Positions from Which Photographs Were Taken 320
127. Picture A# 321
128. Picture D# 322
129. Picture C 323
130. Picture Cb 324
131. Split-Representational Style 336
132. An Example of a Poster Where Important Meaning Is Communicated through Topological Cues 351
133. An Example of a Poster Which Uses Porjective Cues to Convey Important Messages 353

> . . . To be learning something is the greatest of pleasures not only to the philosopher but also to the rest of mankind, however small their capacity for it; the reason of the delight in seeing the picture is that one is at the same time learning. . . .
>
> Aristotle
> Poetics

[illegible]

PART I

CHAPTER I

PICTURES AS A MEDIUM OF COMMUNICATION

Fundamental to any kind of education is communication. Modern schools rely on literacy as the basic method for disseminating ideas and information. There is no question but that literacy is one of the most distinguishing characteristics of modern society and an intellectual tool that has important consequences for the way we think and learn. But it is also true that the absolute number of illiterates in the world is increasing each year and that the great majority of village people in developing countries still cannot read or write. Adult literacy programs have begun to make inroads but lack of environmental support has left new literates with little opportunity for improving or even retaining their skills. Appropriate reading material is often scarce and most villages are practically devoid of the written messages that are so ubiquitous in urban areas such as road signs, advertisements, and labels on food items and other necessities. One difference between formal and nonformal approaches to education in developing countries is the degree of reliance on literacy for delivering messages.

Using Visual Aids in Development Work

The spoken word and demonstration are the traditional modes of communication in villages. These methods can be effectively supplemented, however, with appropriate visual aids. Furthermore, to the extent that ideas can be conveyed through the use of visual materials, illiterate learners will be able to carry out many steps in their heads that might otherwise have to be physically demonstrated, with all the consequent savings in time and possibilities for mass distribution.

It has been estimated that as much as ninety percent of our information about the world is received through our eyes.[1] Visual communication can cover a wide range of information sources. Doob distinguishes between natural and mediated "communicators" and between intentional and unintentional ones.[2] Freshly ploughed furrows show that a field is ready for planting. A furrowed brow, on the other hand, may be a sign of displeasure. A wedding ring, a haircut or a broken tooth may be an indication of marital status depending on the culture. A church can be distinguished from a supermarket by its architectural design. Some of these visual signs may be universal but many are culture specific.

A great many kinds of visual aids are presently being used in development work. Pictures are among the most useful because they are easy to transport and to reproduce. Pictures may be photographs or drawings, they may be color or black and white, they may be printed or projected. Projected pictures, such as filmstrips or slides, are effective for larger audiences, whereas printed pictures in the form of flipcharts, flash cards, or photonovellas are suitable for individuals and small groups. Larger printed pictures may also be used as posters or billboards. Pictures are often accompanied by written words in the form of captions, dialogue, or accompanying text. If the words are simple, they may be understood by villagers with rudimentary literacy skills; otherwise they can be read out loud by the extension worker or even a local school child. Pictures may also be accompanied by a verbal explanation such as a narration that goes with a filmstrip. Narrations can be spontaneous or prerecorded or even broadcast over the radio. A special case of pictures with sound is the motion picture or television. Chalkboards and flannelgraphs are visual aids that enable the speaker to construct his picture as he talks. In addition to depicting objects realistically, pictures can also present caricatures or cartoons as well as symbolic information in the forms of charts, graphs, maps and diagrams.

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[1] Andreas Fuglesang, *Applied Communication in Developing Countries: Ideas and Observations* (Uppsala: The Dag Hammarskjold Foundation, 1973), p. 118.

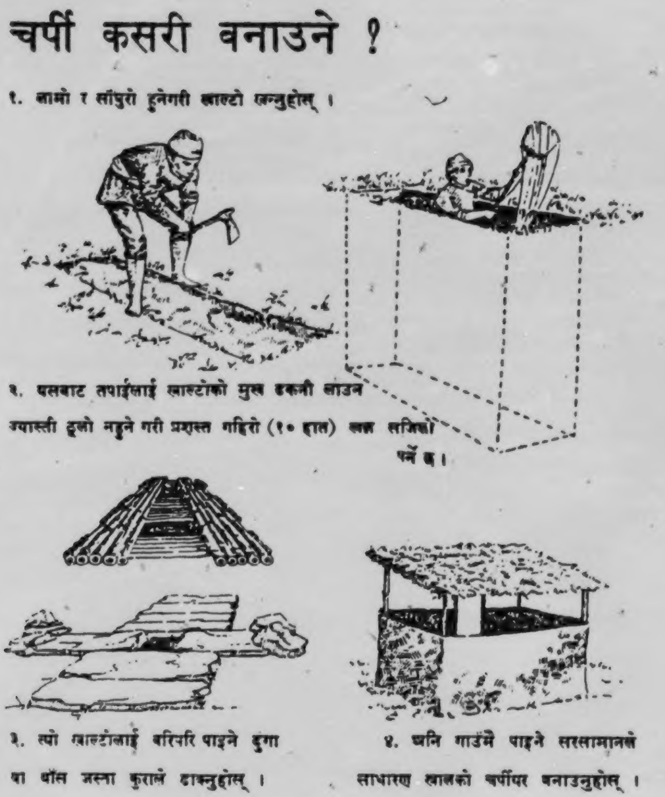
[2] Leonard W. Doob, *Communication in Africa: A Search for Boundaries* (New Haven: Yale University Press, 1961), pp. 56-145.

There are a number of other teaching devices that also have a strong visual emphasis. Models are an example, where real objects are shown in miniature or enlarged. Plays and puppet shows rely on both sight and sound, and the costumes, masks and sets convey visual information. Nevertheless, pictures remain the most economic and versatile of all visual aids, both in terms of cost and ease of distribution, and it is with pictures that our discussion will be primarily concerned.

The possible uses of pictures in what the United Nations has recently begun to call "development support communication" are as varied as the pictorial formats themselves. Pictures can be used to attract attention. A handful of photographs or a poster is bound to draw a crowd of curious onlookers in any village where pictures are rarely seen. Pictures are used for identification, as in the case of agriculture or health work where they are used to help villagers identify harmful insects. Again, pictures can evoke associations, such as using a wheel or an ox as the symbol of a political party. With regard to the physical tasks of development, pictures can provide new information about problems of construction, spatial placement and the use of equipment. They offer an efficient means of recall. If villagers have been given information in a talk or by demonstration, pictures can remind them of the points they have learned or the steps they must follow. In the political and psychological tasks of development, pictures have been effectively used for propaganda purposes, China being a prime example. Pictures can also stimulate the imagination. Television in the poorer countries has been acknowledged as one of the key contributors to the "revolution of rising expectations." Finally, pictures may also be used simply to give pleasure. Often villagers will put on the walls of their huts any postcard or picture from a magazine they can get their hands on.

Pictures may be described as iconic or isomorphic symbols because they convey information about form and structure that corresponds in some feature by feature way to structures in the real world. Reality is depicted in essence. Writing, on the other hand, is symbolic in an abstract way because it makes use of entirely arbitrary conventions. Nothing, for example, in the configuration of the word _man_ would indicate its meaning. The letters represent the sounds of a verbal referent. The verbal referent, which is a class name, is already an abstraction, and writing it requires a second level of symbolization. Thus to derive any meaning from the written symbol man one would have to go through two levels of abstraction and a great deal of prior learning. A pictorial representation is iconic because it makes use of many of the same perceptual principles we have learned through our everyday contact with the world. The series of pictures in Figure 1 was prepared by UNICEF to convey information to village people about building a pit latrine. Even someone who is entirely illiterate in the Nepali language and cannot read the captions can still understand the main points of the message from the illustrations.

Not all pictorial material, however, is without abstract elements. It is a short step, perhaps, from an aerial photograph of a town to a map, but a map, in spite of its one-to-one relationship with the real world, begins to take on many of the qualities of an abstract symbol. It becomes abstract because we are unaccustomed to seeing towns from an aerial perspective, so the view no longer coincides with our normal perception. In the same way, diagrams may become so simplified and schematic that they approach the abstract symbolism of writing. Someone without much knowledge of electronics might still be able to make sense of diagram (a) in Figure 2 but not of diagram (b). The symbols of electronics are similar to written words. They express certain relationships and interacting processes that must be understood and learned. But even maps and diagrams retain structural information that is iconic.



चर्पी कसरी वनाउने ?

१. लामो र साँघुरो हुनेगरी खाल्टो खन्नुहोस् ।

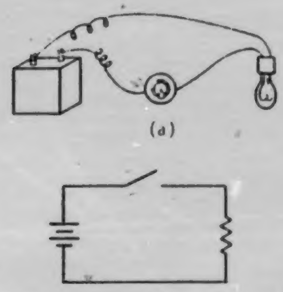
२. यसबाट तपाईलाई खाल्टोको मुख ढकनी लाउन ज्यास्ती ठूलो नहुने गरी प्रशस्त गहिरो (१० हात) सम्म सजिलो पर्ने छ ।

३. त्यो खाल्टोलाई वरिपरि पाइने ढुंगा वा घाँस जस्ता कुराले ढाक्नुहोस् ।

४. अनि गाउँमै पाइने सरसामानले साधारण खालको चर्पीघर बनाउनुहोस् ।

FIGURE 1

Poster in Nepali showing how to build a pit latrine.
(Source: UNICEF, Kathmandu, Nepal)



(a)

(b)

FIGURE 2

Two degrees of pictorial abstraction: (a) blueprint diagram, (b) circuit diagram.

It is also possible that pictures which are perfectly identifiable may nevertheless be endowed with an arbitrary meaning. The skull and crossbones as a sign of danger is an example of how abstract meaning has been culturally attributed to an iconic symbol (Figure 3). Furthermore, many of the features of pictorial communication we are accustomed to in the West such as arrows and lines of motion are arbitrary conventions. It will be one of the tasks of those who are designing visual materials for rural development purposes to differentiate between those aspects of pictures that derive directly from perceptual principles and those that

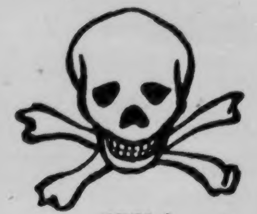


FIGURE 3

A recognizable object having arbitrary meaning.

are arbitrary and therefore abstract so that intelligent use can be made of both.

In spite of these cautions, pictures have a great many advantages that make them suitable for communication work. Their isomorphic relationship to the real world tends to make them precise and unambiguous. It is usually unnecessary for a sophisticated viewer to have to guess what is being depicted. In a mechanical system the shape and position of the component parts are the key to the system's functioning. Pictures can convey the spatial and structural information that will reveal how the mechanism works. Because pictures are permanent they can be used again and again, which is not the case with a talk or a demonstration. Permanence also makes it possible to use pictures when the communicator himself is not present or at a place and time of day of the learner's own choosing. Pictures can both be used to supplement a lecture, which is one-way communication, or in a small group to stimulate dialogue. Furthermore, the use of pictures is not limited only to recognition of things previously seen. Of course no knowable object can be completely unique, as the observer would have no way of comprehending it. But so long as the object depicted is not too divorced from our experience, we can form a fairly accurate concept of it through pictures. A child going to Paris for the first time will be able to recognize the Eiffel Tower, without being told, if he has seen it in pictures.

An instance of learning through pictures

We were personally made aware of some of the power and the limitations of pictures when we were serving as a Peace Corps volunteer in a remote village in Nepal. The children in that village had never been to any city and had rarely had a chance to look at any pictures. They were fascinated with our magazines, and we were fascinated watching them look at our magazines. We had often wondered what it might be like to see pictures of a highly advanced civilization or of our own world three or four hundred years from now. These children were doing just that when they looked through our magazines, which showed super highways, skyscrapers, department stores, modern kitchens and so forth. But instead of scrutinizing each picture and studying each detail and asking questions as we might have expected, these children would race through the magazine as fast as they could turn the pages. When they came to the end they would set it aside and ask for another. Only occasionally would they pause to point out a cow or a cat or some such familiar object. One time we stopped them at a picture of a fairly typical American living room and we pointed to a chair and asked if any of them knew what it was. They were familiar with chairs because they used them at school and we had two or three simple wooden ones in our house. The chair in the pictures, however, was upholstered and none of them could recognize it. When we told them it was a chair, they looked at us in disbelief. Nor could they see in any way how that was a picture of a chair! Our houseboy was often among them when they went through the magazines. We had taught him how to set our modest table with a fork on the left and a knife and spoon on the right. Once, as they were racing through a magazine, our houseboy caught sight of a fairly small black and white shot of a politician at a dinner party. What caught his eye was the elaborate place setting which had several forks, knives, spoons, a dinner plate, a salad plate, a bread and butter plate, a water glass, a wine glass, and so forth, all in front of one person. He cried out in such astonishment that we looked up from our reading. He had stopped the others from turning the page while he studied the picture and counted all the forks and plates. The others, of course, had no idea what he was looking at. Many times after that incident, while setting the table, our houseboy referred to that picture. It occurred to us that the problem of communicating with pictures was a great deal more interesting than we had at first realized.

Visual Communication

Modern theories of communication have borrowed many of their concepts from electronics. The basic components in a communications system are a source, a channel and a receiver. In development work this is further broken down in the following manner: the source, which is often a government agency, develops ideas and information into messages which are "encoded." The encoding may be in the form of words or pictures or even a song or a puppet show. The message is then transmitted along a channel which could be any number of institutions that have direct access to the villages, such as the national radio, a newspaper, the school system, the health posts, the agricultural extension workers or the mails. The receiver, of course, is the village people themselves or particular groups within the village, such as teachers or women, and it is important that they be able to "decode" the message in order to understand it.

The electronic model is further elaborated with concepts such as noise (interference in the transmission) and feedback (response from the receiver), but what concerns us most in our study of using pictures in rural development work is the process of "coding" and "decoding" messages. The content of the messages and the channels of transmission will largely depend upon the particular goals and institutions of each nation. To the extent, however, that generalizations can be made about peasant thinking and intelligence, many of the methods of "coding" and "decoding" will be applicable in all situations of human resources development. In studying the process of "coding" and "decoding" information in pictures we will begin by looking at perception itself, with particular reference to picture perception. This will provide a foundation for discussing the kinds of messages that lend themselves to being coded in pictorial form.

Current theories of perception

Theories of perception may be roughly divided into three broad categories: those which see perception as primarily a passive function of the mind, those which see it as an active process which involves selection and judgment, and those that describe it as a form of biological adaptation and stress interaction between the mind and the objective world.[3]

The idea that perception is essentially a passive and autonomous function, one that does not involve any mental strain or fatigue, was advanced as far back as the seventeenth century by the empiricists, who felt that all knowledge was gained through experience. They saw the mind at birth as a blank slate, a tabula rasa on which experience engraved its marks. An exponent of this point of view was the British philosopher George Berkeley, who held that all things exist only insofar as they are perceived or known. Carrying his argument further, Berkeley suggested that the universe exists because it is known by God. Among the modern psychological theorists perhaps E.J. Gibson comes the closest to the early empiricist point of view. She takes the position that perception reflects directly the information present in the environment and that perceptual development involves increasing differentiation in the detection of information. During the eighteenth century a new element was added to the picture by the nativist school. Kant agreed with the empiricists that the material of our knowledge came from without, but postulated innate or a priori structures in the mind that determined "how" we perceive. This is largely the position taken by modern Gestalt psychologists such as Wertheimer. The nativist position emphasizes retinal and cortical functions and places experience in a secondary role.

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[3] See N.H. Pronko, R. Ebert, and G. Greenberg, "A Critical Review of Theories of Perception" in A.H. Kidd and J.L. Rivoire (eds.), Perceptual Development in Children (New York: International Universities Press, Inc., 1971), pp. 57-78.

With advances in the study of anatomy and especially of the nervous system, physiologists in the nineteenth century began to emphasize the active functioning of the brain. Perception was described as a process of interpreting visual images in terms of possible objects. The meaning of a present event or object was determined, in part, by past learning. Helmholtz, the German physiologist and physicist, proposed that the mind makes "unconscious inferences" when confronted with visual stimuli. These inferences are mental assumptions, appraisals, or selections. A recent development along these same lines is the theory of "probabilistic functionalism" espoused by Brunswick which takes the view that perception is a kind of weighted average of our past experiences. While Helmholtz's position stressed meaning in the interpretation of objects, Brunswick and others have emphasized cumulative habit.

In spite of the apparent differences between the passive and the active theories of perception, they share important points in common. Both approaches are in agreement that we do not perceive objects directly. Objects reflect light to the eyes and stimulate the receptor cells. What we experience is neither the object nor the light, but the nerve energies that are aroused. Perception is basically seen as a process that occurs entirely inside the head. Furthermore, the key role of experience in both the earlier passive theories and the more recent active approaches makes all of them empirical to varying degrees.

The twentieth century has witnessed the emergence of a third approach to the problem of perception which stresses interaction between the organism and the environment. J.R. Kantor developed a theory that was event-oriented, an event being comprised of both an organism and a stimulus object. The organism is endowed with nerves, retinae, brains and all the biological raw materials that make light sensitivity possible. But the light, and the particular features of the object-to-be-seen are present in the environment. Both variables participate in the psychological event. In this way thinking, learning and perceiving are not functions of the organism alone nor do they occur only in the mind. Rather they are located in the total field and emerge from a process of interaction.

Cross-cultural psychologists have emphasized the role of ecological and behavioral interactions. J.W. Berry has espoused an approach to perception that might be called "ecological functionalism."[4] He suggests that the "ecological demands" placed on a group of people and their cultural adaptation to the ecology leads to the development of certain perceptual skills. The modes of cultural adaptation that interact with perception include language, arts and crafts, and socialization practices. For example, if a culture's language is rich in geometrical and spatial terms, Berry argues that these would assist in transmitting spatial and orienting concepts and information which are consistent with the spatial demands placed on the group by their ecology. A more extreme argument for the impact of culture on perception is the Sapir-Whorf hypothesis which holds that the structure of language itself influences the manner in which things are perceived. Berry's view, however, emphasizes interactions rather than causal sequences.

The Swiss genetic epistemologist, Jean Piaget, has also devoted a considerable amount of attention to the problem of perception.[5] He sees perception as primarily a mode of biological adaptation, a position that also emphasizes organism-environment interaction. Piaget distinguishes between primary perception and perceptual activity. Primary perception consists of split-second encounters with a set of stimulus points. The parts of the stimulus-object that are centered or fixated are usually overestimated relative to those parts that are seen only peripherally, making primary perception prone to distortion. Perceptual activity is an active process of coordinating encountered points in the visual environment, the effects of which are to counteract the distortions of the more passive primary perceptions. Piaget does not, however, regard perception as an autonomous mode of adaptation, but as a dependent subsystem and an inferior one at that, within the larger context of intelligence. Piaget distinguishes more sharply between perception and intelligence than do other contemporary psychologists, and places such activities as judgment, classification, inference, and organization in the realm of intelligence. Whereas intelligence becomes rigorous and capable of yielding absolute knowledge, perception is at best probabilistic.

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[4] J.W. Berry, "Ecological and Cultural Factors in Spatial Perceptual Development," Canadian Journal of Behavioral Science, 3, No. 4 (1971), pp. 324-336. Also found in J.W. Berry and P.R. Dasen (eds.), Culture and Cognition: Readings in Cross-cultural Psychology (London: Methuen and Co., Ltd., 1974), pp. 129-140.

[5] See John H. Flavell, The Developmental Psychology of Jean Piaget (Princeton: D. Van Nostrand Co., 1963), pp. 350-356.

Piaget's model contains passive, active, and interactional elements, and indeed all of the current theories overlap in many details. They all give importance to both biological structure and the role of experience, the differences among them being mainly a matter of emphasis. These theories of perception have given rise to two important approaches to the special problem of how we communicate with pictures.

Picture perception

The perception of pictorial material raises special problems because pictures are both objects themselves and surfaces so treated as to allow us to see something else as well. We may distinguish between direct perception and indirect perception. Direct perception reveals the various attributes of the picture-as-object such as the brush strokes, the photographic grain, or the texture of the paper. Some modern art, which consists of lines or splotches of color, is only meant to be perceived indirectly. Indirect perception refers to the representational element in pictures which allows us to look beyond the picture-as-object and perceive other scenes or events which have been depicted. The picture may be as small as a postcard and yet allow us to perceive indirectly an object as large as a mountain. R.L. Gregory has summed up the special nature of picture perception in this way:

> Pictures are such artificial inputs that the surprising thing is not that they may appear ambiguous, uncertain, paradoxical or distorted representations of objects, but that we make anything of them at all.[6]

Two current approaches to picture perception stem directly from the dominant schools of perceptual theory described in the preceding section, one approach emphasizing active selection on the part of the observer and the other based on passive reception. We shall briefly examine each.

Gregory, following the tradition of Helmholtz, maintains that sensory data is essentially ambiguous. Like many of the "constructive" theories of perception, Gregory's analysis draws heavily on the use of visual illusions to support his case. He cites the example of the distorted room constructed by Adelbert Ames. Although the room is made up of oddly shaped walls at various angles (see Figure 4), they are so constructed that when the eye is placed at a critical spot, the room appears to be perfectly rectangular. As the wall at the far end of the room recedes, it becomes correspondingly larger, so that the image presented to the eye is indistinguishable from that which would be presented by a normal room. When people are placed in the room, the person at the far corner, who is twice as far away from the viewer as the one in the near corner, actually looks shrunken because the room gives such a powerful illusion of being normal (Figure 5). Of course the illusion would be destroyed if the viewer could supplement the visual data by using both eyes or by moving his head to change parallax. Because a picture is flat, however, and no new information is added by using both eyes or by changing one's viewpoint, Gregory argues that any two-dimensional image could represent an infinity of possible three-dimensional shapes.[7] Thus the brain is forced

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[6] R.L. Gregory, The Intelligent Eye (New York: McGraw-Hill, 1970), p. 102.

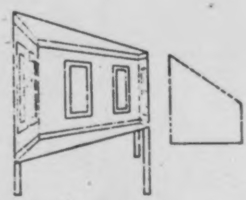

FIGURE 4

Diagram of the Ames room. (Source: M.D. Vernon, The Psychology of Perception (Harmondsworth: Penguin Books, Ltd., 1962), p. 126)

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[7] Gregory, The Intelligent Eye, p. 25.

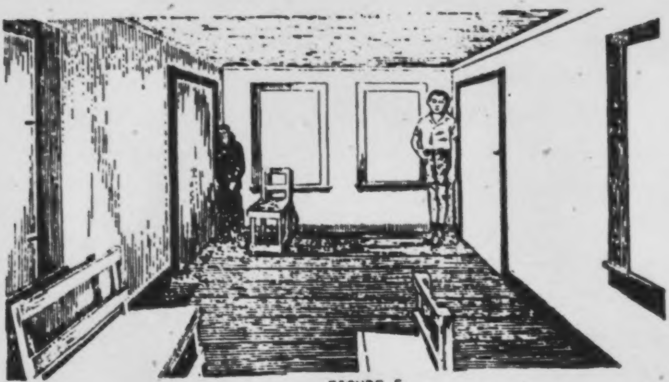

FIGURE 5

Drawing of the appearance of the Ames room. (Source: M.D. Vernon, The Psychology of Picture Perception, p. 127)

to interpret the sensory data in terms of the world of objects and settle on the best solution to the problem.

As further evidence that our mind modifies and interprets perceptual data, Gregory asks us to consider how rarely accurate representation of space is found in works of art. The artist does not depict the world exactly as he sees it, but rather as he constructs it in his mind. This is demonstrated by the development of perspective in the history of art. The image as it comes to the retina is in exact geometrical perspective, every feature being halved in size with the doubling of distance, as in a photograph. However, because we know that a person who is walking away from us is still the same height, his image is subtly modified in our minds by perceptual size scaling. The optical shrinkage is compensated for by what we know to be true--that his size is constant. If painting represents primarily what is stored in the brain of the artist, it is not surprising that perspective came late in the history of art. It is for this reason that so much of our older art looks flat. Perspective was discovered by the painter-architects of the Renaissance who were interested in showing how their buildings would look from various points of view. The formal rules of geometrical perspective were finally set down by Leonardo da Vinci. It is the photographic image, which records the world according to strict optical principles, that has made modern man accustomed to seeing perspective in pictures. Pictures are like language in Gregory's view. Neither is suitable for unique cases, for "there must be shared perceptual hypotheses for communication to occur."[8]

A very different view of picture perception is advanced by John M. Kennedy which is based on a "registration" theory of perception offered by J.J. Gibson and E.J. Gibson.[9] In this view perception is determined by the data available to the perceiver, not by any mental processes that alter or supplement it. We open our eyes, look around, and simply "register" our surroundings. Kennedy accurately points out that the "constructive" view of perception relies heavily on optical illusions to prove the point that sensory data is ambiguous and that the mind can be fooled. But illusions are rare instances in a world where light generally obeys clear-cut and orderly principles. For example, light normally travels in a straight line from its origin to our eyes. Any deviation from such straight lines, as in the cases of mirrors or lenses, are usually well-defined, as by the frame of the mirror, for example. Kennedy's approach to picture perception begins by proposing a distinct "ecology" of light which is based on the lawful relationships of light to its origins. If we understand how information about the world is generally available to our eyes, we will be in a better position to understand how pictures provide information.

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[8] Gregory, The Intelligent Eye, p. 120.

[9] John M. Kennedy, A Psychology of Picture Perception (San Francisco: Jossey-Bass Publishers, 1974).

Kennedy's ecology of light defines the various aspects of light that give information about its source. Briefly he states that light is reflected from any surface in all directions where there is a transparent medium such as air. Reflected light maintains its original direction until there is a change in the medium. Any place at which light is available he calls a point of observation. Rays of light from the surfaces in the environment, each having its own color and direction, converge upon a particular point of observation, pass through it, and diverge away from it. All the rays of light that arrive at any given point of observation constitute an optic array. Kennedy analyzes the properties of optic arrays that give us information about their origins in the environment.

Since light leaving a surface maintains its direction, we know that adjacent elements of an optic array come from adjacent directions. We also know that as the position of an origin changes, so will the direction of the light coming from it. We do not know, however, if two optically adjacent surfaces are also materially adjacent. One may be much further away than the other. Depth perception is ambiguous if a solitary point of observation is considered. However, if the observer looks with two eyes or moves his head, thus obtaining information across space or time, this difficulty disappears. The more distant surface has some of its area occluded by the nearer surface. The addition of a second point of observation, either through movement of the eye or through binocular vision, causes some of the occluded area to appear, making it possible to determine which area is more distant.

We also know that surfaces are typically fairly homogeneous in texture. Abrupt changes will usually occur only when there is a change in the texture or the pigmentation of a surface. Therefore we can reasonably assume that areas lying within such discontinuities are areas of continuous surface. The texture of a surface will also give information about its orientation--whether it is flat, curved or slanted--information that we might not be able to deduce from shape alone.

The ecology of light provides a framework for determining the basic principles of pictorial layout. If lines can depict the major elements that create a visible environment, then presumably they have the capacity to depict anything that is visible. It is Kennedy's thesis that lines can be informative because they are capable of depicting the abrupt changes which occur in the real world as visible discontinuities of surface, pigment, illumination and texture.

Surfaces are delineated by their contours. The visible terminations of a plane surface are called occluding edges. In the case of curved surfaces, such as a sphere, the visible terminations are called occluding bounds. Line segments can be used to depict both occluding edges and occluding bounds. In any given optic array, nearer surfaces will occlude more distant ones, and beyond the surfaces will be backgrounds which are further still from the point of observation. Abutting angles, where two surfaces meet, can also be depicted by single lines, as can any discontinuity in a surface where the space between the margins of the discontinuity is too fine to be registered. For example, a line can depict a door in a wall or a crack in a board. However, if the crack is too wide, two lines would be required. In the same way, a single line can depict a wire, but a thick rope would require two lines, one for each edge. Whether a line segment depicts an occluding edge, an occluding bound or a wire depends upon its context.

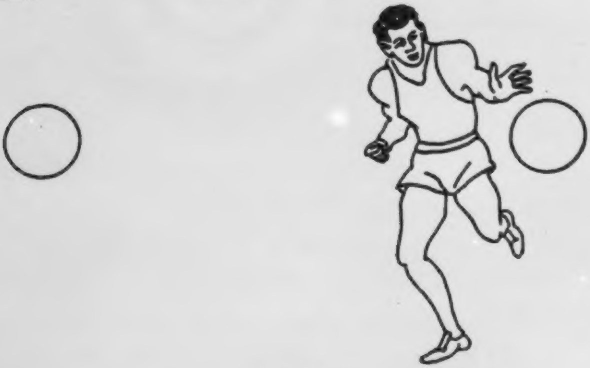

FIGURE 6

A line depicting an occluding bound.

Other visible discontinuities that do not involve surface structure can similarly be represented by lines. Discontinuities in pigmentation, for example, such as the design on a flag, can be shown in outline form. Discontinuities in illumination, such as shadows or highlights, though rare in outline drawings, can also be depicted. Discontinuities in texture without a change in surface or pigmentation are rare but occur in special cases,such as the hem of a sweater. These too can be represented by lines.

Kennedy's analysis deals primarily with outline drawings, both because they are commonly used for communication work and because they give the minimum amount of optic information. For example, outlines usually lack information about texture and shading. Therefore, if outline drawings are sufficient for communication, then three-tone drawings and photographs, not to mention the addition of color, will be all the more powerful. Kennedy's theory of picture perception is based on the premise that pictures provide the same optic information as the pictured object or scene. He feels that making pictures is an art, but that recognition of depictions is largely a gift allowed us by the environment.

Whether pictures are so artificial and ambiguous that it is a wonder we make anything of them at all as Gregory asserts, or whether pictures are precise and unambiguous because they capitalize on well-defined principles of everyday perception as Kennedy maintains is a question that can only be answered by looking at the evidence of research. This question is also basic to the study described in Part II of this paper. It may be that in some cases a picture is ambiguous and in others perfectly straight-forward depending on the kind of communication task it is being asked to perform. Before attempting to arrive at any conclusions, we should examine the kinds of information that pictures can most readily convey. One way to approach this task is to compare pictorial communication with spoken language.

The Language of Pictures

Pavlov and others have shown that animals are capable of indirect reaction. They are also able to express themselves by means of sounds and gestures, what might be called an animal language. In fact at the level of emotional language, what Fuglesang calls "exclamation,"[10] there are many parallels between human and animal speech. Only man, however, is capable of articulation. An indispensable ingredient which is characteristic of all human language is missing in animals: there are no signs which have an objective reference or meaning. No animal has ever made the decisive step from subjective to objective, from exclamation to articulation. The philosopher Ernst Cassirer wrote, "The difference between propositional language and emotional language is the real landmark between the human and the animal world."[11] This difference, Cassirer adds, along with the lack of images, has prevented animals from ever achieving even the least beginnings of cultural development.

Cassirer distinguishes between signs and symbols. Animals, especially if they are domesticated, are extremely sensitive to signs, such as expressions of the human face or modulations of the voice. There have been astonishing examples of dogs and horses that can seemingly master arithmetical problems. Closer investigation revealed, however, that the animals were reacting to involuntary movements on the part of their owners. If the owner were not present, the animal could not answer the question. There is no doubt that animals are intelligent and capable of genuine insight in solving problems. But their imagination and intelligence are practical, based on signs which are part of the physical world. Conditioned reflexes are in essence very different from the symbolic thought of man. Symbols have only a functional value and are part of the human world of meaning. It is undeniable, according to Cassirer, that "symbolic thought and symbolic behavior are among the most characteristic features of human life, and that the whole progress of human culture is based on these conditions."[12]

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[10] Fuglesang, Applied Communication, pp. 19-20.

[11] Ernst Cassirer, An Essay on Man: An Introduction to a Philosophy of Human Culture (New Haven: Yale University Press, 1944), p. 30.

It is difficult to distinguish between practical and symbolic intelligence or to trace its development in the child. The case of Helen Keller, however, demonstrates dramatically the distinction. When she was seven she made a discovery that was for her an intellectual revolution--that everything has a name. Previously she had learned to associate a thing or an event with a sign in the manual alphabet, but each sign was restricted to a particular case. Helen Keller made the transition from sign to symbol when she discovered that words were not merely fixed associations but symbols with universal applicability.

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[12] Cassirer, An Essay on Man, p. 27.

Without symbolic imagination and intelligence, reflection and abstraction would be impossible. Impairment of speech by brain damage, for example, results in a complete loss of ability to solve problems that require theoretical or reflective activity. People suffering from aphasia can perform the tasks of everyday life but are not capable of thinking in general concepts. Without symbolism, Cassirer maintains, man's life would be confined within the limits of biological need and practical interests. It could find no access to the "ideal world" which is opened to him by art, philosophy, science and religion.

We have mentioned before that pictures may range from iconic to abstract. By abstract we are not referring to the kind of modern art that is devoid of indirect content. Abstractions in pictorial representation refer to arbitrary conventions which, similar to writing, must be learned to be used properly. This does not mean, however, that even iconic representations are entirely free of arbitrary elements. Even the most faithful color photograph of someone we know well, though instantly recognizable, is still a frozen moment recorded on a flat surface, probably surrounded by a border and reduced in size, and therefore very different from the person it represents. We once showed a lifesize color poster of a puppy to our cat. The cat instantly recoiled and bared its teeth, but cautiously approached, sniffed the poster, and immediately turned away without further interest. Movement, depth and smell are absent in pictures, betraying their artificiality no matter how faithful or convincing they might otherwise be. Pictures may be said to fall on a continuum of abstraction, iconic representation being at one extreme.

The reason that pictures are unique to human culture is that like language, they are symbolic. And because they are symbolic, they are capable of making propositional statements. It is true that animals can be trained to respond to visual cues, such as shape or color or relative size. They can isolate perceptual factors and make what appear to be distinctions of reason. But such responses only involve direct perception; the visual cues are signs and not symbols. In the same way we might look at a piece of modern art and find it interesting but "meaningless." It has no objective reference, and therefore is capable only of exclamation and not of articulation.

Pictures which provide indirect perception can take on a symbolic function in the same way words do. A picture of running children on a road sign refers not to any particular children but to a class concept. If the word "children" had been printed on the sign it would have had the same meaning as the picture, which in the particular context is to inform drivers to exercise caution because children are likely to be present.

Propositional utterances are made up of content words, nouns and verbs, which may be modified by adjectives or adverbs. In addition to these there are structure words, prepositions and conjunctions, which help to indicate the relationship of the various content words to one another. A closer look at the parts of speech will help to define some of the limitations of pictures as a medium of communication.

Nouns may be classified as proper or common. A proper noun is the name of a particular person, place or thing, such as Sir Isaac Newton or the Taj Mahal. Pictures are extremely useful in depicting proper nouns and even excel verbal descriptions in many instances. Common nouns are the name applied to a class or any example of a class of people, places or things. Each culture has its own system of categorization but all are functionally equivalent. As we mentioned in our comparison of animal and human language, it is the class name used as a symbol or a concept that frees the mind from slavery to the particular. Once we have mastered the class "chair," for example, as a concept, it can be generalized to new instances without further learning. Common nouns are of two types: concrete and abstract. Like proper nouns, concrete nouns can be easily represented pictorially. They are the kinds of things a photograph could be taken of. A picture of an apple, for example, although it is a particular apple, can be understood conceptually, as an instance of the class of things we call apples. It is possible to group pictures of apples, bananas and pears and call them fruit just as we could group the words or the real objects. Pictures used in this way, where a particular person, place or thing is not intended, are the equivalent of concrete common nouns.

One peculiarity of the human mind is the creation of imaginary things. A unicorn or a mermaid, for example, does not exist in nature. Through the power of imagination, however, such creatures can become part of our cultural world. Concrete nouns are not restricted to real objects

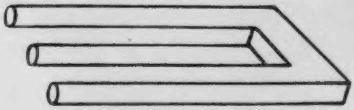

FIGURE 7

Devil's tuning fork: an example of an impossible object.

alone, and imaginary concepts can be expressed in both words and pictures. Similarly, impossible or self-contradictory objects can be described both verbally and pictorially, as in Figure 7.

Abstract nouns refer to qualities or attributes, such as honesty or courtesy, and these cannot be directly represented pictorially. Even in life these qualities must be inferred from other things, such as behavior. Our experience gives us many instances of a quality, and our concept of it develops inductively. Once the defining criteria of a concept conform to what is generally accepted in our culture, the concept may be used freely in speaking or writing. However, since we cannot see it directly, we cannot represent it pictorially. The closest we can come is to depict some of the concrete instances that helped us to establish the defining criteria of the concept. For example, if we saw a picture of a man offering his seat to an elderly lady on the bus, we might infer that, among other things, he was courteous. A series of pictures of this sort might enable us to discover that the one thing all the pictures had in common was that they were instances of courteous behavior, and that was the concept the pictures were trying to represent. This would be a most inefficient method of communication, as the concept could be made perfectly clear by uttering a single word. Here, then, is an important limitation of pictorial communication. It is to a large extent limited to concrete subject matter. This does not rule out, of course, the possibility of using arbitrary symbols to represent abstract ideas. A blindfolded woman holding a pair of scales has often been used to symbolize justice, for example, but like the skull and crossbones, this is a culturally defined and arbitrary symbol.

Therefore, although the image itself may be identifiable, this particular use of it would put it nearer the abstract end of the pictorial continuum.

In spoken language we use adjectives to limit or modify nouns. A great many descriptive attributes can be incorporated into pictorial representations, particularly those that are visible to the eye, such as shape, texture, contrast, relative size and so forth. However, attributes that are not apparent merely from looking, such as "heavy," "expensive," or "intelligent" cannot be depicted directly. We only know if a box is heavy if we weigh it or try to move it. Similarly, a quality such as "heavy" would have to be depicted indirectly, such as by writing the weight on the object or by showing a person struggling to move it. Here again, not all qualities even of concrete nouns can be rendered pictorially.

Verbs are important content words that express actions or states of being. Pictures are most useful at representing a state of being. For example, if a bicycle is broken and missing a wheel, a picture can render that situation perfectly. If a man is standing on his head, that also can be illustrated. What pictures cannot easily depict, however, is a negative state--what the bicycle or the man does not look like. This would require the use of an arbitrary convention. A typical example is a "no smoking" sign which shows a man smoking covered by an "x." Thus to represent a negative idea, arbitrary devices must be introduced which place the picture at the abstract end of the continuum. Similarly, past and future states cannot be represented without introducing conventions of some kind.

Actions are more difficult to depict than states of being because pictures are frozen moments. Since actions cannot be perceived directly they must be inferred by the momentary position and orientation of the people or objects in the picture. Such activities as walking, running, pushing and pulling can be depicted fairly clearly. If a man is bouncing a ball, and the ball is shown in mid-air, it may be difficult to know if the ball is on its way down or its way up. If this is important, small lines of motion can be introduced trailing behind the ball and indicating its direction. Since pictures are ambiguous about motion and direction, conventions of this sort are commonly used. Comic books are full of them and have developed a whole vocabulary of what we would call arbitrary pictorial cues to indicate motion, impact, speed and direction. These, of course, do not correspond to anything in the visible world and would be unintelligible to anyone who had not learned their meaning.

In spoken language, structure words such as prepositions are used to indicate relationships among words. Often a spatial relation is indicated as in the case of "above," "below," "in," "around," "among," "against," and so forth. A great many of these spatial relationships can be depicted pictorially because they are part of the visible world of objects. We have mentioned, however, that pictures provide only a single optic array and therefore are ambiguous in depth. When looking at real objects the two and a half inch separation of our eyes yields a slight disparity in the retinal images and these are fused in the brain to give stereoscopic vision. Changing parallax by a slight movement of the head gives similar information about the separation of two surfaces which are optically adjacent. Since both of these primary sources of information are unavailable in pictures, other secondary cues must be sought. The three most commonly used pictorial cues of depth are overlap, perspective, and relative size.

Overlap provides perhaps the best indication of pictorial distance. If an object has a recognizable shape and that shape appears to be interrupted or partially occluded by another surface, the evidence is fairly compelling that the occluded shape is the more distant one. There are cases, however, where two interpretations of the data are possible. The Danish psychologist, Edgar Rubin, used cleverly contrived drawings to demonstrate ambiguity between a figure and its background.[13] Figure-ground reversals are possible in pictures because the primary instrument of depth information, binocular vision, is not available. In Figure 8 one can see alternately a radially marked cross or a concentrically marked cross. The appearance of the concentric markings changes depending upon whether they belong to the figure or to the background. When they belong to the background they do not appear to be interrupted. They seem to continue behind the figure. This is not so when they are seen as

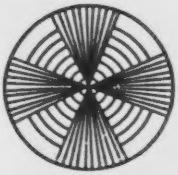

FIGURE 8

Figure-ground reversal. (Source: Gregory, The Intelligent Eye, p. 16) the figure. Ambiguities of overlap such as this are possible in pictures, but Rubin's figures are admittedly contrived. Overlap is normally an unequivocal indication of relative depth, although it does not tell us the degree of separation. Is the more distant object just behind or very far behind the nearer one?

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[13] For a discussion of Rubin's work see Kennedy, A Psychology of Picture Perception, pp. 85-105, and Gregory, The Intelligent Eye, pp. 15-18.

Perspective information is more subtle, but gives us a way to judge degree of depth. It is based on the optical principle that receding parallel lines converge, like the two sides of a railroad track. A rectilinear shape, such as a cube, does not appear optically as having any right angles or any edges that are either parallel or equal in length (Figure 9). All of the surfaces appear to be irregular

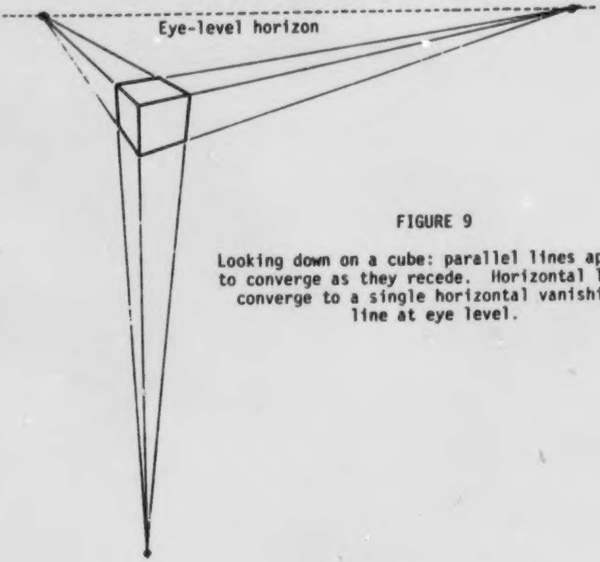

FIGURE 9

Looking down on a cube: parallel lines appear to converge as they recede. Horizontal lines converge to a single horizontal vanishing line at eye level.

trapeziums. Perceptual scaling, however, enables us to see the object as a cube. The well-known Necker cube is ambiguous precisely because it lacks perspective information so there is no indication which face is closer (Figure 10).

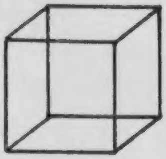

FIGURE 10

The Necker cube.

The third cue of pictorial depth, object size, is a special case of perspective information. We have mentioned before that an object is optically halved in size with the doubling of distance. Of course if conflicting cues are also present, as in the case of the Ames distorted room, the depth information is partially nullified. But like the figure-ground reversals and the Necker cube, the Ames room is also a contrived example.

Each of these three secondary cues of pictorial depth is based on the laws of optics and what Kennedy would call the ecology of light. They would all be present, for example, in a photograph, which gives the same optic information for depth that an observer would receive by looking at a scene through a peephole. In fact a pair of photographs taken simultaneously a few inches apart and viewed stereoscopically, one image being presented to each eye, gives extremely persuasive depth information. As all three of these secondary monocular cues are based on perceptual principles and contain no arbitrary additions, spatial information in pictures must be put at the iconic end of the scale.

Relationships of time are also expressed verbally by prepositions, and these cannot be depicted directly in pictures. Like actions, temporal relations must be inferred. If we see a picture of a man with an ax in his hand and next to him a tree is lying on the ground, we may infer the man has just chopped down the tree. An alternative method would be to show two pictures, one with the man actually chopping, and the second with the tree on the ground. But this introduces the notion of a series of pictures indicating different points in time. Although this convention is commonly used, it might not be understood without prior learning. Similarly, conjunctions, which express logical relations, such as "and," "or," "if," "because," "unless," "therefore," etc., cannot be depicted pictorially.

By comparing the language of pictures with spoken language we have been able to shed light on the strengths and limitations of pictorial communication. Pictures are extremely useful for depicting particular concrete things, what are usually referred to as proper nouns. They are equally suitable for depicting generalizations of concrete things. A picture of a house or a triangle can serve as a concept, similar to a common noun. Spatial relationships and states of being can also be represented pictorially. Actions, on the other hand, are often ambiguous and have to be inferred from the context or specified by the addition of conventional lines of motion. Temporal and logical relationships and abstract concepts are extremely difficult to depict and also require the introduction of arbitrary conventions. In using pictures for development work it will be important to understand that the more remote the connection between the drawing and its meaning, the more prolonged will be the efforts required to understand and use it. The history of pictographic writing provides an illuminating example of the limitations of communicating through pictures.

The earliest cave paintings and rock engravings were man's first attempts to express himself in graphic form. Through a process of simplification and stylization these pictographs became the precursors of writing. As a method of communication, the disadvantages of pictographs are evident. A great many signs are needed to depict all the important objects in a culture. Furthermore, since the signs are concrete, only a limited number of things can be expressed. The Sumerians and Egyptians extended the range of their symbols by introducing phonetic elements. For example, the Sumerians could use the sign for _ti_, an arrow, to stand for another meaning of _ti_, life, a concept not easy to represent pictorially. However, any system of writing where a sign stands directly for its referent is extremely complex. Furthermore, the addition of new signs becomes a fairly arbitrary process, which makes them exceedingly difficult to interpret. Goody and Watt state that a minimum of 3,000 characters must be learned before one can be reasonably literate in Chinese, and with a total repertoire of 50,000 characters to be mastered, it usually takes about twenty years to become completely proficient.

> China therefore stands as an extreme example of how, when a virtually non-phonetic system of writing becomes sufficiently developed to express a large number of meanings explicitly, only a small and specially trained professional group

> in the total society can master it, and partake of the literate culture.[14]

With alphabetic literacy, on the other hand, it is as easy to express a verb as a noun and past or future action as a state of being.

It is important, then, to accept the limitations of pictorial communication. The very fact that pictographic forms of expression capable of extended discourse have been developed demonstrates the capability of pictures when used abstractly. The virtue of using pictures for development work among illiterate villagers, however, is presumably due to their iconic quality, which makes them less abstract than writing. Surely it is more useful for a villager to become literate, not to mention being easier and quicker, than to spend time on learning innumerable pictorial abstractions. Therefore, the distinctions between iconic representation and the arbitrary elements that push pictures toward the abstract end of the continuum are important. It may be that the introduction of a certain number of abstractions, such as cues of motion, direction, time, or negation will vastly extend the usefulness of pictures in communication work, but at the same time communication specialists must be aware of the inherent limitations of the language of pictures.

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[14] Jack Goody and Ian Watt, "The Consequences of Literacy," Comparative Studies in Society and History, 5, No. 3 (1963), p. 313.

CHAPTER II

CROSS-CULTURAL STUDIES IN PICTURE PERCEPTION

One of the primary aims of cross-cultural research in psychology has been to determine the importance of learning in perceptual competence. By examining tribes and cultures that are very different from Western peoples it is presumably possible to shed light on fundamental questions about the relative roles played by experience and physiological structures. A great many culturally-linked variations in perceptual behavior have been observed, but the difficulty has been to go beyond this generalization and determine what the controlling factors are. Cross-cultural studies in perception have focused on two important questions: Are there particular experiences that lead to different interpretations of ambiguous stimuli, such as visual illusions? Secondly, to what extent is the perception of artificial representations, such as photographs and line drawings, influenced by experience? The investigation of these two questions has a double interest for the present research. In the first place it will give some insight into the perceptual and cognitive processes of illiterate villagers and help to distinguish any differences between their psychological abilities and those of Western peoples. Knowing more about the way traditional people see and think will enable us to avoid making unfounded assumptions about what kinds of messages they can or cannot understand. Secondly, since cross-cultural psychologists have used pictures for a great deal of their research in perception, their findings provide a wealth of material on the particular problems associated with pictorial communication.

The Study of Visual Illusions

As early as the turn of the century the Cambridge University expedition to the Torres Straits, between Australia and New Guinea, dispelled the then popular notion that primitive people had unusual sensory gifts but were innately inferior in abstract throught. W.H.R. Rivers, who was in charge of physiological and psychological studies, carried out a large number of observations on memory and perception. Among other things he tested a battery of visual illusions and compared his findings with Western norms.[1] For some illusions there was no appreciable difference. For others the native populations seemed to be less susceptible than Westerners. Rivers concluded that the natives he tested did not possess any greater visual acuity than Europeans, but because of their long practice in attending to minute details of the environment their powers of observation were superior.

Allport and Pettigrew, studying Rivers' findings, distinguished between illusions having object connotation (such as a street scene) and those that did not (such as a rotating spiral).[2] They pointed out that it was with respect to the illusions having object connotation that the natives were generally less susceptible. In order to determine the influence of meaning on perception they tested Zulu and European subjects with a device invented by Adelbert Ames, the rotating trapezoidal window. The window is so constructed that as it rotates, the length of the longer edge always appears longer to the eye, even when it is further away, making the window appear to sway rather than to rotate. The authors refer to the device as "a dramatic masterpiece of ambiguous stimulation." The explanation for the illusion, according to Ames, is that we are familiar with rectangular windows and we assume that this window is also rectangular. Furthermore, we have learned to interpret longer lines as coming from nearer objects. Therefore, the longer edge of the window is seen as always being nearer, and the window appears to oscillate rather than to rotate. Ames' explanation is clearly of the active empiricist school and rests upon the kinds of "unconscious inferences" described by Helmholtz.

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[1] W.H.R. Rivers, "Introduction and Vision," in A.C. Hadden (ed.), Report of the Cambridge Anthropological Expedition to the Torres Straits (Cambridge: Cambridge University Press, 1901), Vol. II.

[2] Gordon W. Allport and Thomas F. Pettigrew, "Cultural Influence on the Perception of Movement: The Trapezoidal Illusion among Zulus," Journal of Abnormal Psychology, 55, No. 1, 1957, pp. 104-113.

Allport and Pettigrew chose to compare the effects of the illusion with Zulu children because their culture is virtually devoid not only of windows, but of rectangles and straight lines. Zulu huts are round, their stockades are circular and their fields follow the irregular contours of the land. If the illusion were wholly the product of experience, it was felt that rural Zulus would report the illusion less frequently than urbanized Zulus or Europeans. It was found that when the window was viewed under conditions that gave the maximum illusion effect (monocularly at twenty feet), as many rural Zulus reported the illusion as urban Zulus or Europeans. But when marginal conditions prevailed (binocularly at ten feet) and there was perceptual conflict, it was found that rural Zulus reported the illusion significantly less frequently. The authors concluded that object connotation, or meaning, based on relevant cultural experience helps to determine the nature of perceived movement under marginal conditions.

The "carpentered-world" hypothesis

The most comprehensive study of susceptibility by various cultures to visual illusions was carried out by Segall, Campbell and Herskovits over a ten year period in fifteen African societies.[3] The authors, like Allport and Pettigrew, take an active empiricist position but whereas the latter stressed meaning in the interpretation of ambiguous stimuli, Segall and his associates stress cumulative habit. Following Brunswick's theory of "probabilistic functionalism," they suggest that perception is a function of a weighted average of our past experiences. Our experiences create unconscious assumptions which cause us to attach particular significance to the various cues in our environment. Our interpretation of these cues is generally valid but not in every instance. Brunswick called this "ecological cue validity." Optical illusions present us with cues that are normally functional but which in the particular circumstances are misleading; they are "ecologically unrepresentative."

The authors hypothesized that the basis of most geometric illusions is our tendency to see them as representations of three dimensional space. The Sander parallelogram, for example (Figure 11), appears to our unconscious mind to be a rectangle extended into space. The bias in this illusion, then, is to judge the left diagonal as longer than it is. Similarly, in the Muller-Lyer illusion (Figure 12), it is hypothesized that the horizontal line is unconsciously seen as the edge of a rectangular object such as a box. In the arrowhead figure it would be a front edge, in the tailed figure an inner edge. Since an inner edge is assumed to be further away it would have to be actually longer in order to appear the same as the front edge. Thus the length of the tailed horizontal is typically overestimated. In an environment where we are surrounded by rectangular surfaces and neat right angles, the authors suggest that this inference habit has great "ecological validity" and functional utility. In areas

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[3] Marshall H. Segall, Donald T. Campbell and Melville J. Herskovits, The Influence of Culture on Visual Perception (Indianapolis: Bobbs-Merrill Co., Inc., 1966).

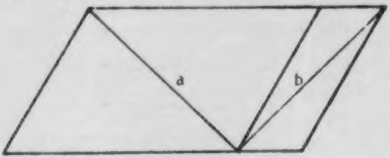

FIGURE 11

The Sander parallelogram: which line is longer, a or b?

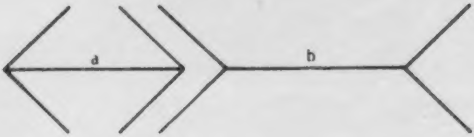

FIGURE 12

The Muller-Lyer illusion: which line is longer, a or b?

where people are not surrounded by rectilinear surfaces this inference habit might be absent. It would be reasonable to suspect that such people would be less susceptible to the illusion. Segall and his associates call this the "carpentered-world" hypothesis.

In order to confirm their theoretical proposition, the authors chose a different illusion which they felt non-Western groups would be more susceptible to. This illusion, they suggested, would operate according to the principle of "the foreshortening of receding horizontals." Lines extending away from the observer on the horizontal plane appear to be shorter than transverse lines of equal length. For people who live on the flat plains, the furrows of a ploughed field extending away from an observer appear on the retina as vertical lines. For such people there would be ecological validity in interpreting vertical images as greatly foreshortened lines extending horizontally away from the point of observation. Such a person would tend to overestimate the length of the vertical line in the horizontal-vertical illusion (Figure 13). People who live in cities or in the forest, on the other hand, are more accustomed to interpreting cues of height and would be less susceptible to the illusion.

The authors tested five different illusions based on these principles. Each illusion was presented several times to each subject, with the discrepancy varied slightly in each

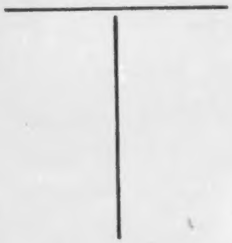

FIGURE 13

The horizontal-vertical illusion: which line is longer?

instance. It was found that in the case of the Sander parallelogram and the Muller-Lyer illusion, European and American samples made significantly more illusion-supported responses than did non-Western groups, while on the variations of the horizontal-vertical illusion non-Western respondents showed more susceptibility. The authors felt that the "carpentered-world" hypothesis was confirmed and concluded that our perceptions are indeed culturally influenced though there is no gulf separating the mind of modern man from that of primitive man. The findings, they assert,

> point to the conclusion that to a substantial extent we learn to perceive; that in spite of the phenomenally absolute character of our perceptions they are determined by perceptual inference habits; and that various inference habits are differentially likely in different societies. For all mankind the basic process of perception is the same; only the contents differ and only because they reflect different perceptual inference habits.[4]

A number of other authors have challenged the "carpentered world" hypothesis. Pollack suggests that illusion susceptibility could be just as well explained on biological grounds.[5] He noted that the groups tested by Segall and his colleagues varied not only in the carpenteredness of their environments but in their skin color as well. Skin color is directly related to optical pigmentation and Pollack argued that the findings could just as easily demonstrate that susceptibility to the Muller-Lyer illusion is lower when optical pigmentation is higher. Berry confirmed this possibility. He found that when the relationship between carpenteredness and pigmentation was statistically controlled, optical pigmentation was more closely related to Muller-Lyer illusion susceptibility than carpenteredness.[6]

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[4] Segall, Campbell, and Herskovits, The Influence of Culture on Visual Perception, p. 214.

[5] R. Pollack, "The Carpentered World: Or Biology Stay Away from My Door." Paper presented at City University Graduate School and University Center, New York, N.Y., December, 1972. Cited in Joseph Glick, "Cognitive Development in Cross-Cultural Perspective," in F.D. Horowitz (ed.), Review of Child Development Research (Chicago: University of Chicago Press, 1975), Vol. 4, pp. 611-612.

It seems impossible at present to demonstrate that any single factor is responsible for differences in illusion susceptibility. The premise of the "carpentered-world" response to the illusions is that they are unconsciously seen as three-dimensional projections. Illiterate villagers, however, are unaccustomed to seeing three-dimensional projections on flat surfaces. The illusion may just as easily derive from culturally learned inferences having to do with cues of depth in pictorial material. Glick discusses an experiment by Leibowitz and Pick investigating the Ponzo Illusion.[7] The two oblique lines of the illusion appear to Westerners like railroad tracks converging on the horizon (Figure 14). A horizontal bar placed across these lines close to their apex will be judged as longer than an equivalent bar placed at the open end of the lines. Leibowitz and Pick compared the reponses of Pennsylvania college students, Uganda college students, Guam college students and Ugandan villagers. The Ugandan villagers showed almost no susceptibility to the illusion while the other groups demonstrated as much as 30 percent overestimation. Unfamiliarity with

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[6] J.W. Berry, "Muller-Lyer Susceptibility: Culture, Ecology or Race?" International Journal of Psychology, 6, 1971, pp. 193-197.

[7] Joseph Glick, "Cognitive Development in Cross-Cultural Perspective," pp. 614-615. Leibowitz and Pick presented their findings in a paper read at the Eastern Psychological Association meetings, April 1, 1971.

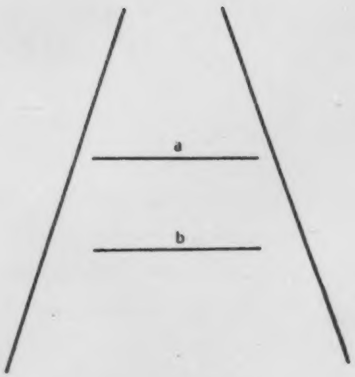

FIGURE 14

The Ponzo illusion: which line is longer, a or b?

pictorial cues of perspective may actually work to the advantage of the Ugandan villagers, while the other groups have to fight against such culturally learned conventions and try to accept the picture as a flat representation rather than one in depth.

It has been previously pointed out that the active empiricist approach relies upon ambiguous stimuli to demonstrate perceptual differences and support the position that "to a substantial extent we learn to perceive." Although illusions are exceptional phenomena because they are specially contrived, no clear distinction can be made between illusions and true perceptions. All visual information is subject to universal laws of light and therefore all illusions must have true elements. At the same time all true perceptions are prone to some degree of subjective shaping. If we do indeed learn to perceive it is precisely because the laws of light are universal and ambiguous conditions are so rare that perception develops in basically a similar pattern in all cultures. Campbell points out that if any culture were to perceive in a radically different way it would be impossible to confirm communication and therefore perceptual differences could not be ascertained. "In the end, it is because in great bulk we perceive alike (respond alike) that we can note small differences in perception."[8] Cross-cultural research in susceptibility to geometric illusions is only valid because of the similarities in perception that make small differences detectable.

One way of ascertaining whether the lines in any of the illusions are the same or not is to apply a third line to each of them respectively--in other words, to measure them. This would involve the intellectual operations of transitivity and conservation of length, and if our measuring device were sufficiently accurate our answer would be certain. It is in this sense that Piaget maintains perception is at best probabilistic and never capable of the rigorous absolute knowledge of intelligence. It is therefore to a considerable degree the inherent limitations of perception as a mode of adaptation that account for there being different responses to ambiguous stimuli. This point is demonstrated by the evident fact that these differences would be greatly reduced if intellectual operations were employed.

While the studies described so far explain differences in perception on the basis of meaning or cumulative habit, an interactionist theory would account for the data equally well. The similarity of perception in all cultures is due to the fact that it develops through a process of interaction with an environment which is essentially the same in its most important features--namely, that visual information derives from laws of light which do not vary from one place in the world to another. At the same time, the inherent limitations of perception will lead to uncertainty when conditions are ambiguous, and under such circumstances a variety of secondary interactions having to do, for example, with language, child-rearing practices, whether the community engages in hunting or farming, or even the carpenteredness of the visual environment, could well lead to culturally patterned variations in response.

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[8] Donald T. Campbell, "Distinguishing Differences of Perception from Failures of Communication in Cross-Cultural Studies," in F.S.C. Northrop and H.H. Livingston (eds.), Cross-Cultural Understanding: Epistemology in Anthropology (New York: Harper and Row, 1964), p. 325.

Understanding Representational Material

Different activities require different kinds of perceptual information. Walking down a crowded street requires topological cues, building a house makes use of euclidean principles, catching a ball depends on projective information. Michael Cole suggests that each activity such as writing, walking, carving or building proceeds in its own particular medium.[9] When a person begins to perform in a new medium such as drawing, he has to learn to attend to new perceptual cues. Is this also true of the perception of graphic representations? Herskovits reported showing a Bush Negro woman in Dutch Guyana a black and white photograph of her own son.[10] He was surprised when she turned it this way and that, unable to make sense of it. It appeared that to the untrained eye photographs are seen as concrete objects in themselves rather than as representations of something else. The first thing that would catch the attention of an uninitiated person would be the perfectly cut rectangular shape and the clear white border. The patterns of various shades of grey would be the least striking feature. Herskovits concluded that the photograph is an arbitrary convention that is not necessarily shared by all peoples. But once understood, he felt, the perception of content is compelling.

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[9] Michael Cole and Sylvia Scribner, Culture and Thought (New York: John Wiley and Sons, Inc., 1974), p. 95.

[10] Segall, Campbell and Herskovits, The Influence of Culture on Visual Perception, p. 32.

Hudson reported unconventional responses on a projective test used to obtain information about the aspirational levels of Bantu factory workers.[11] The pictures were unambiguous, three tone, graphic representations of situations familiar to Bantu culture. In one of the pictures a man was shown standing in front of a thatched hut and a number of respondents interpreted the ragged thatch as wings and thought the man might be a devil or an angel. In another picture a man was shown speaking to a group of workers, with a factory in the background. The speaker's hand was outstretched in such a way that it was positioned over the tops of the factory chimneys. Several protocols referred to a madman warming his hands in the smoke of the chimneys.

These examples suggest two problems involved in the perception of representational material, one having to do with the identification of content and the other with the understanding of pictorial space.

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[11] W. Hudson, "Pictorial Depth Perception in Sub-Cultural Groups in Africa," The Journal of Social Psychology, 52, 1960, pp. 183-208.

Pictorial recognition

Accounts of primitive people who were unable to identify pictured objects suggested the hypothesis that pictorial recognition is a learned ability. In order to test this possibility Hochberg and Brooks raised their child for nineteen months with a minimum of exposure to pictorial art.[12] They removed labels from jars, kept picture books out of his reach and never spoke to him of pictures or depicted objects. He was encouraged to play with a wide variety of solid objects and toys and learned their names. At nineteen months the child was presented with a series of twenty-one outline drawings and photographs of objects he knew (see Figure 15). He was able to name almost all of them successfully, indicating that, insofar as one child is concerned, the recognition of three-dimensional objects on a two-dimensional surface was not an ability that required learning. In a similar vein Kennedy reports cases of monkeys trying to pick up drawn objects or putting their heads close to pages on which watches have been drawn as though listening for ticking.[13]

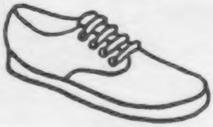

FIGURE 15

Outline drawings such as this were identified by a child with no previous exposure to pictorial art.

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[12] Julian Hochberg and Virginia Brooks, "Pictorial Recognition as an Unlearned Ability: A Study of One Child's Performance," The American Journal of Psychology, 75, No. 4, 1962, pp. 624-628.

[13] Kennedy, A Psychology of Picture Perception, p. 80.

In a cross-cultural study comparing the performance of Zambian school children and Zambian adults drawn from a remote rural area Deregowski confirmed the findings of Hochberg and Brooks.[14] Subjects were required to select an animal model, given a photograph and asked to name both the pictorial stimuli and the models. He found that both groups were able to match models to photographs at a level that was above chance when the animals depicted were familiar. If they were unfamiliar the school children were superior to the adults, whose responses did not differ from chance responses. Deregowski concluded that "the evidence obtained did not indicate that the subjects were unable to detect pictorial stimuli, nor that they had serious difficulties with recognition of such stimuli if the depicted stimuli were familiar to them."[15]

Fuglesang experimented with the effectiveness of different pictorial styles in Zambia.[16] Pictures of everyday scenes were shown to individual subjects in four versions: a black and white photograph, a simple line drawing, a silhouette, and a "block-out," which was a photograph with all of the background removed. All four were the same size and were shown simultaneously in random order. The subject was told that the four pictures showed the same thing and was asked to describe what he saw. When the content was identified the subject was asked to point out the picture in which he first recognized it. The overwhelming majority pointed to the "block-out" (230 responses). Next in preference was the photograph (128), followed by the silhouette (30) and lastly the line drawings (15). Fuglesang attributed the high performance of the "block-outs" to the fact that they boldly separate the figure from the background. Although the photographs were selected frequently, Fuglesang surmised that the cluttered background was not important for comprehension in these examples and only interfered with correct identification of the subject. The poor performance of the line drawings was probably not an indication of their inability to communicate but a matter of relative preference for the richer and more lifelike detail of the photographic medium.

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[14] Jan B. Deregowski, "Responses Mediating Pictorial Recognition," The Journal of Social Psychology, 84, 1971, pp. 27-33.

[15] Ibid., p. 27.

[16] Andreas Fuglesang, "Communicating with Illiterates," in Daphne Rawson-Jones and Geoffry Salk (eds.), Communicating Family Planning (London: International Planned Parenthood Federation, 1972), pp. 68-78.

A similar study, carried out in Nepal, tested the same four styles that Fuglesang describes plus a three tone drawing and a stylized drawing such as a stick figure or cartoon.[17] In this study the respondent was shown only one version of each picture. Combining the results of twelve different pictures, each in six styles, the authors were able to rate the performance of each style according to the percent of correct identifications (Table 1).

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[17] Diana Fussell and Ane Haaland, Communicating with Pictures in Nepal (Kathmandu: UNICEF, 1976).

TABLE 1

PERCENTAGE OF CORRECT IDENTIFICATIONS OF FAMILIAR OBJECTS DEPICTED IN SIX REPRESENTATIONAL STYLES

Three tone drawing	72%
"Block-out"	67%
Line drawing	62%
Silhouette	61%
Photograph	59%
Stylized drawing	49%

They felt that the superiority of the three tone drawing (Figure 16) to the "block-out" was due to its greater sharpness and clarity. Unlike Fuglesang's results, the line drawing was found to be more effective than the photograph or the silhouette. This may be due to the fact that the task of the Nepalese respondents was somewhat different from that of the Zambian subjects. The Zambians were asked to select from several styles viewed simultaneously, whereas in Nepal the task was to identify a pictured object in the style given. The photographic medium may have been preferred in Zambia, but this does not necessarily mean the line drawing would not have been understood.

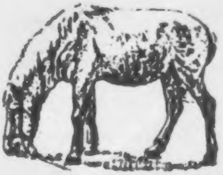

FIGURE 16

An example of a three tone drawing.
(Source: Fussell and Haaland, Communicating with Pictures in Nepal, p. 16)

In testing pictorial depth perception in South Africa, Hudson used outline drawings.[18] He felt that these would provide the simplest and least graphically contaminated medium for the representation of appropriate depth cues in standard scenes. He found that the objects in his pictures, such as lines representing the contours of hills, the edges of a road or the horizon, were consistently misidentified. Such lines, Hudson felt, tend to become symbolic and unrealistic. Similarly, Mundy-Castle, using Hudson's drawings in Ghana, found that children were able to recognize objective representations correctly in terms of their class, but identified them according to past experience of objects within the class.[19] For example, the deer in Figure 17 was always recognized as an animal, but was often called a goat or a sheep which are animals frequently seen in the villages in the region of the study. With the more abstract pictorial representations, however, identifications often fell within a different class from that intended by the artist. The two lines demarcating the road were frequently identified as a hill or a tree. The horizon line was almost never correctly identified, usually being described as an object such as a stick,

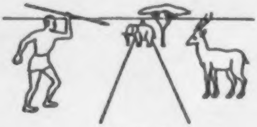

FIGURE 17

One of Hudson's outline drawings (Source: Hudson, "Pictorial Depth Perception . . . ," p. 186) a ruler or a piece of string. Mundy-Castle found that in the case of the road and lines showing the contours of hills there was an increase in correct identification corresponding to age, but not in the case of the horizon line. He states:

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[18] Hudson, "Pictorial Depth Perception . . . ," p. 202.

[19] A.C. Mundy-Castle, "Pictorial Depth Perception in Ghanaian Children," International Journal of Psychology, 1, 1966, pp. 290-300. Reprinted in D.R. Price-Williams (ed.), Cross-Cultural Studies (Harmondsworth: Penguin Books Ltd., 1969), pp. 117-131.

> As a general conclusion from these observations, it is proposed that the likelihood of correct identification of pictorial items is greatest if they are realistic representations of familiar objects, least if they relate to abstract concepts. . . . The hill and road lines certainly refer to objective reality, but these drawings are rendered in a highly abstract manner, designed to emphasize distance cues with minimal attention to objective realism. To interpret them correctly requires a knowledge and understanding of both the mode of graphic representation and of the conceptual aspects incorporated in the representation.[20]

A fairly comprehensive cross-cultural study of the perception of line drawings was carried out by Duncan, Gourlay and Hudson among Bantu and white school children in South Africa.[21] They studied five groups of children in different stages of acculturation. Test items included a broad range of pictorial conventions such as stylistic preferences in depicting the human figure (realistic, cartoon and stick figures), lines of implied motion, the ability to identify a person in a series of pictures, borders (drawn and implied), foreshortening, and shadows. All but the last two of these are among the more arbitrary elements which are frequently used in outline drawings.

As expected, the findings indicated that the understanding of many pictorial conventions correlated closely with degree of acculturation. All groups showed increased comprehension with age and with exposure to pictorial material, whether inside the classroom or outside. All groups preferred the realistic depiction of the human figure and liked the stick figure least. The cartoon style was significantly more popular among Europeans than Bantus. Cues of implied motion were found to be highly arbitrary and their comprehension depended upon acculturation. The identification of a single person in a series of panels also proved to be difficult for the less acculturated children, although scores improved with age. Reading frames from left to right was a convention, the authors felt, that had to be learned. Shading was found to be often misinterpreted. It was sometimes seen as dirt, or if on a face, as scars.

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[20] A.C. Mundy-Castle, "Pictorial Depth . . . ," pp. 121-122.

[21] H.F. Duncan, N. Gourlay, and W. Hudson, A Study of Pictorial Perception Among Bantu and White Primary School Children in South Africa (Johannesburg: Witwatersrand University Press, 1973).

Hudson studied the understanding of foreshortening in line drawings, contrasting the performance of white primary school pupils and illiterate black laborers.[22] One picture showed the back view of a man stepping up on a step with one leg. Another showed the back view of a man with only his upper arms as far as the elbows visible. Hudson reports that differences in perception were marked. The white pupils generally saw the two men in depth and reported one to be climbing a step and the other doing something with his hands which were hidden from view. The illiterate black sample saw the two pictures as flat and in both cases reported that the man appeared to be maimed or injured in some way. We have mentioned previously in discussing the late emergence of perspective in the history of art that the artist depicts the world not exactly as he sees it, but rather as he constructs it in his mind. Early cave drawings demonstrated a twisted or Lascaux perspective in which an animal drawn in profile was shown to have two horns, two ears, four hooves, etc. Hudson in the same article reports that drawings of cows collected from black students attending an art school in Rhodesia reveal the same phenomenon. Drawings done by black secondary school pupils for a poster contest showed motor cars drawn in twisted perspective. Side views had a front grille and two headlights. Just as the proper depiction of perspective and foreshortening must be studied and learned by artists, recognition of these stylistic devices may also require some explanation. Even though we recognize a real cow or motor car from the side, a picture may be enough of an abstraction that we may be taken aback if all the features we expect to be there are not visible.[23] In another test Hudson presented two pictures of an elephant from above. In one the legs were splayed out as though it were a rug; the other view was correct. The illiterate Bantus usually preferred the first rendition, saying the perspective view showed an elephant that must be dead because it had no legs. Fuglesang found evidence that Africans recognize line drawings by examining details.[24] In a series of drawings of animals half of the respondents failed to identify a drawing of a goat. Later it was discovered that the tail, a seemingly insignificant detail, had been incorrectly drawn. It went down instead of up.

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[22] W. Hudson, "The Study of the Problem of Pictorial Perception Among Unacculturated Groups," International Journal of Psychology, 2, 1967, pp. 90-107. Reprinted in Price-Williams, Cross-Cultural Studies, pp. 132-158.

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[23] For a discussion of how various cultures have solved the problem of representing three-dimensional reality in pictures, see James Mangan, "Cultural Conventions of Pictorial Representation: Iconic Literacy and Education," Educational Communication and Technology, 26, no. 3, 1978, pp. 245-267.

[24] Fuglesang, Applied Communication, p. 81.

The comprehension of pictorial space

The perception of depth in a picture is a conflict situation where objective cues of flatness must be ignored in order to participate in the artistic convention that a flat picture can represent a scene in three dimensions. We have previously mentioned that the primary cues of depth in the real world, which are the retinal disparity resulting from binocular vision and change of parallax brought about by moving one's point of observation, are not available in pictorial material. Secondary, monocular cues, such as superimposition, object size and perspective must be relied upon to convey a sense of depth in drawings. Photographs may also have cues of shading and texture gradation: shadows can create a modelling effect and a regular texture becomes coarser as it approaches the point of observation. Since the cues of pictorial depth all derive from the ecology of light, the question for cross-cultural study is whether the perception of depth is spontaneous or whether like arbitrary conventions it depends upon other factors such as learning.

The classic cross-cultural study of pictorial depth understanding was carried out by Hudson in South Africa.[25] His test materials were designed to isolate the pictorial depth cues of object size, object superimposition, and perspective. In each of the six outline drawings used to investigate horizontal pictorial space (Figure 18) an elephant is positioned between a human figure and an antelope.

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[25] Hudson, "Pictorial Depth Perception . . . ."

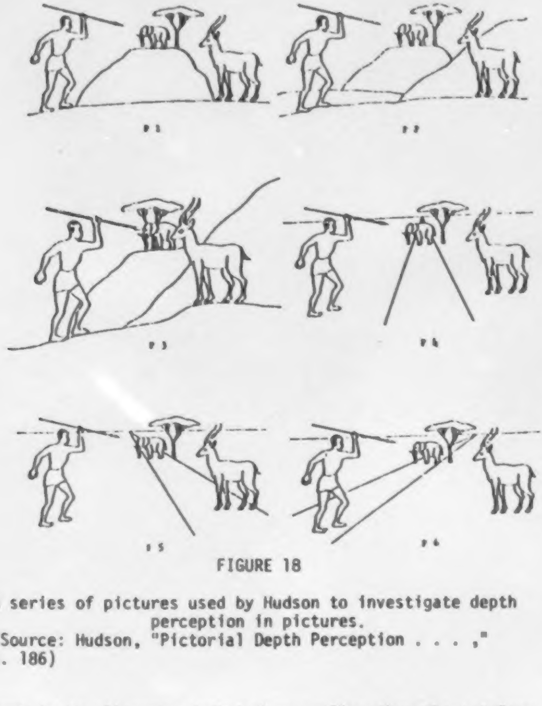

FIGURE 18

A series of pictures used by Hudson to investigate depth perception in pictures.
(Source: Hudson, "Pictorial Depth Perception . . . ," p. 186)

The elephant is in all cases depicted as smaller than the antelope. In addition to this object size cue the second and third pictures contain additional cues of overlap. The last three pictures have perspective lines representing a road vanishing to a horizon. The hunter's spear in all pictures is aligned at both the elephant and the antelope.

Among other questions Hudson asked "Which is nearer the man, elephant or antelope?" Hudson reports that a number of his subjects took as long as an hour per picture to respond. The conflict arises from the two possible answers to the question. A person seeing the pictures in depth would see the antelope as being nearer. A person seeing the picture only two-dimensionally would say the elephant is nearer. In the first instance the relative distance of the two animals from the man is understood to exist in projective space, while in the latter they are seen to exist in topological space. For the respondent who sees the elephant as closer, pictorial proximity is topological and objects which are adjacent to one another in the picture are perceived to be close to each other in pictorial space. Hudson relates that some of the more educated informants (graduate teachers) appealed to the tester for guidance because they saw two possible answers. The less educated and illiterate samples did not experience this conflict and perceived the pictures two-dimensionally in a majority of cases. This was confirmed by answers to the question "Is the man aiming at elephant or at antelope?" In all samples the candidates choosing the elephant as the hunter's quarry also perceived the elephant as closer to the hunter. A photograph of models in a similar configuration, which Hudson considered to be less symbolic and more realistic, was also perceived two-dimensionally by the illiterate respondents. School-going samples, however, perceived three dimensions in a photograph more readily than in outline drawings.

Hudson found that of the three cues of depth tested, superimposition led most frequently to three-dimensional perception. He surmised that the representation of pictorial distance is more symbolic with perspective than with overlapping. Part of the difficulty was undoubtedly due to misidentification of the lines associated with the depth cues. We have mentioned previously Mundy-Castle's finding that many respondents mistook the horizon line, the edges of the road and the contours of the hills for other things such as ropes, sticks, rivers, rulers, and so forth. Hudson found a direct relationship between incorrect identification of such items and two-dimensional perception. Correct identification, however, did not necessarily lead to depth perception. Hudson found that school-going samples, both white and black, perceived pictorial depth more frequently than illiterates but that intelligence and educational level were factors in pictorial depth perception only in the case of white school-going samples. Hudson hypothesized that white school-going subjects were generally superior in perceiving depth because of an informal process of almost continuous exposure to pictorial material at home as well as in school. Formal training in picture perception was not part of any school curriculum. Hudson concludes:

> . . . the critical feature for pictorial depth perception appears to be adequate exposure to the appropriate experience. Exposure occurs during formal schooling and in informal training, but in both cases instruction in the specific experience is not systematic. Formal schooling does not appear to provide sufficient exposure to the experience during the formative period for perceptual organization.[26]

Mundy-Castle also suggests that specific kinds of stimulation are critical for the development of pictorial depth perception. Very few children in his study in Ghana responded to the depth cues in Hudson's pictures. Mundy-Castle reports:

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[26] Hudson, "Pictorial Depth Perception . . . ," p. 205.

> Surveys undertaken in the communities and homes of all the children studied revealed no evidence of activities such as reading, drawing, painting, looking at pictures, pattern-making, or playing with constructional toys, and it was exceptional for a child to have used a pencil prior to going to school; furthermore, most of the parents of the children were illiterate. The opportunity for informal pictorial experience was therefore negligible.[27]

Deregowski carried out a number of studies of pictorial space perception in Zambia. He asked subjects to construct geometrical models according to drawings. He found that a significant proportion of subjects which were judged to be two-dimensional perceivers according to Hudson's tests built three-dimensional models. Many of these, however, were distorted and oddly oriented. Deregowski concluded that it was not possible to apply Hudson's findings to all types of pictorial material.[28] In another study Deregowski investigated the problem of pictorial orientation.[29] Photographs were made of a model Landrover sitting on a rectangular board. Subjects were asked to adjust the car until it was "just as shown in the picture." In general they were unable to do so and their responses showed they assumed the camera to have occupied the position which they themselves occupied at the moment. Deregowski suggests two possible explanations. The first was egocentrism such as the kind described by Piaget, which would cause the subject to fail to distinguish between his own viewpoint and that of other observers. A simpler explanation, and Deregowski felt a more plausible one, stemmed directly from the subject's unfamiliarity with pictorial material. This by-passes questions about developmental stage or intellectual level and corresponds to the positions of Hudson and Mundy-Castle. As part of the same study Deregowski investigated the effect of meaning on pictorial orientation. Again using models, Deregowski took photographs of a hunting scene. The first picture depicted a hunter and two buffalos. In the second and third pictures one buffalo in turn was removed. In all the pictures the hunter was aiming in the same direction so that in two of the pictures his line of aim passed through one of the buffalos, but not in the third. Subjects were asked to arrange the figures "just as in the picture." Deregowski found that "meaningfulness" was the most influential variable although the angle from which the scene was photographed played a part in the magnitude of the errors committed. Deregowski concluded that interpreting the orientation of a depicted object may be influenced either by the point of view from which it is portrayed or by the pictorial context. Errors may arise owing to a tendency to render a depicted scene meaningful in the eyes of the observer.

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[27] Mundy-Castle, "Pictorial Depth Perception . . . ," p. 129.

[28] Jan B. Deregowski, "Difficulties in Pictorial Perception in Africa," H.D.R.U. Reports, No. 1 (Lusaka: University of Zambia, 1966). Cited in Alastair Heron, "Studies of Perception and Reasoning Zambian Children," International Journal of Psychology, 3, No. 1, 1968, pp. 24-25.

[29] Jan B. Deregowski, "On Perception of Depicted Orientation," International Journal of Psychology, 3, No. 3, 1968, pp. 149-156.

Leach distinguished between two levels of spatial understanding in pictures: pictorial depth interpretation and pictorial space comprehension.[30] Pictorial depth interpretation is a relatively simple process in which the subject estimates the distances lying between himself and elements in the picture. In answer to the question, "Which of the two elements, a and b, is nearer to you?" the subject is merely required to estimate and compare two distances. Pictorial space comprehension is seen as a higher order process which requires the manipulation of several variables. Leach suggests that in Hudson's drawings, in answer to the question, "Which is nearer the man . . . ?" the subject is required to understand the spatial arrangement between three points of a triangle viewed obliquely from a distance. While pictorial depth interpretation requires a fairly simple schema of linear constancy the pictorial space comprehension task depends upon a conceptual schema that conserves the constancy of a triangular plane upon a horizontal surface as its apparent dimensions change in response to the viewer's height and distance from it. Leach found that 84% of the third grade Shona children tested in urban and rural Rhodesian schools were capable of consistent pictorial depth interpretation, but only 24% were capable of consistent pictorial space comprehension. The evidence suggests that depth interpretation precedes pictorial space comprehension and that they do not occur simultaneously. Leach cites as corroborating evidence the fact that twice as many third grade Tanzanian children were shown to be able to conserve distance as were able to conserve area.

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[30] M. Leslie Leach, "Pictorial Depth Interpretation: A Prerequisite to Pictorial Space Comprehension," International Journal of Psychology, 12, No. 4, 1977, pp. 253-260.

Thinking with the language of pictures

We have previously discussed the symbolic nature of pictorial material and how a picture can represent a concept or a class idea, much like a common noun. Cross-cultural projective testing has indicated, however, that pictures do not provide equivalent concepts to all groups, even when the pictured objects are easily recognizable. Hudson reports a study among illiterate Bantu adults who were shown a picture that could be perceived as a group fighting. The Bantus reported it as a dancing scene.[31] Action, as we have previously mentioned, can be ambiguous in pictures, and if a group were culturally inclined to avoid aggression it would not be surprising that a dancing interpretation would be preferred. As in the case of visual illusions such as the trapezoidal window, cultural experience may influence the perception of ambiguous action in pictures.

The anthropologist John Collier found that the "reading" of photographs may be highly influenced by culture. He reports that Navajos unaccustomed to seeing pictures tend to read photographs literally.

> We handed a panoramic view to Hosteen Greyhills, a Navajo farmer. He held the photograph firmly with both hands, studied it with some apparent confusion, then began moving in a circle, till finally his face lit up. "That's how he was standing. There is the East. Sun has just risen, it's early in the morning. The picture is in the spring, it was made at Many Farms the first year of farming." The picture was laid down emphatically. "How do you know it's Many Farms?" Greyhills raised the picture again with some irri-

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[31] Hudson, "The Study of the Problem of Pictorial Perception . . . ," p. 136.

> tation. "See . . . those headgates. Nowhere else do they have headgates like that. See . . . it's the stubble of the first cover crop. No hogans. People living over there." He gesticulated out of the picture. "Spring, nothing growing." The picture was laid down for good.[32]

Later the anthropologists studied the photograph with a magnifying glass. The analysis seemed uncanny. They were able to make out shapes that could have been headgates. Further investigation revealed the photograph had been made five years earlier at Many Farms, eighty miles to the southwest in the first year of the agricultural project there at about 7:30 in the morning. Collier attributed the precise reading to the Navajo way of life which depends on astute visual analysis of the environment.

On another occasion, while working with the Cornell-Peru Project at Vicos, Collier had been warned by an excellent fieldworker that the Indians of the Peruvian Andes could not interpret photographs. One day, however, while his wife was washing negatives in a stream, she discovered that the Indian children were able to recognize pictures of their friends in the negative. Further study showed the Peruvian Indians to be fairly astute at recognizing photographs, but their performance was inconsistent. They could recognize pictures of acquaintances a hundred yards down the trail but they could not identify the panoramas of the hacienda buildings. Their faces became blank. Collier concluded that the hacienda was either so hateful they did not want to discuss it or it was so traditionally upsetting that they had in fact never looked at the buildings.[33]

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[32] John Collier, Jr., *Visual Anthropology: Photography as a Research Method* (New York: Holt, Rinehart and Winston, 1967), p. 54.

It has been generally found that memory retains those interests and facts that are considered important by society. Collier's observations seem to suggest that the same process may have a bearing on pictorial recognition. In a test that combined both pictorial stimulation and memory, Deregowski attempted to demonstrate that subjects drawn from an African culture would find it relatively easier to remember and recognize pictures of human faces as opposed to pictures of common domestic objects such as cups than would subjects drawn from a Western culture.[34] His findings, however, did not support his hypothesis. Whereas no significant difference in the recognition of previously seen pictures of faces or cups was found in the Western sample, the African women remembered the pictures of cups better than the pictures of faces. Deregowski attributed this surprising result to the nature of pictures as a stimulus.

> Since pictorial representation of an animate object (such as a human face) involves greater transformation than such a representation of an inanimate object (such as a cup) the former stimuli may become more difficult.[35]

In other words, the picture of a face is more of an abstraction of the object it represents than the picture of a cup. This does not, of course, explain why the Indians Collier observed were unable to recognize the pictures of the hacienda. The evidence does suggest, however, that although photographs of familiar objects are generally recognizable, a pictorial representation may convey a different meaning from that of a real object and that such differences may vary from one culture to another.

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[33] Collier, Visual Anthropology, p. 56.

[34] Jan B. Deregowski, Hadyn D. Ellis and John W. Shepherd, "A Cross-Cultural Study of Recognition of Pictures of Faces and Cups," International Journal of Psychology, 8, No. 4, 1973, pp. 269-273.

[35] Deregowski, Ellis and Shepherd, "A Cross-Cultural Study . . . ," p. 273.

Working with American subcultural groups Sigel found that on simple sorting tasks involving common objects such as a cup, a spoon, etc., while

> the grouping of three-dimensional objects by lower-class children did not differ significantly from that of the middle-class children, the grouping of the pictures between the two socioeconomic groups revealed significant differences where nongrouping responses were significantly greater for lower-class children, showing that lower-class children have greater difficulty making groups with pictures than with objects.[36]

Deregowski investigated what he called "a problem of translation between two distinct levels of abstraction."[37] He tested eighty illiterate Zambian women who had had little previous exposure to pictorial matter on the following arrays: (a) given a photograph they were to select an identical photograph; (b) given a photograph they were to choose an appropriate model; (c) given a model they were required to select an appropriate photograph; (d) given a model they were asked to choose an identical model. Out of 200 responses there were only one and three erroneous responses in the picture-picture and the model-model groups, but 25 and 26 errors in the picture-model and model-picture groups respectively, indicating that in addition to the difficulties involved in performing abstract operations on pictures found by Sigel, there may also be difficulties in operations that require crossing levels of abstraction. A further study by Deregowski and Serpell, comparing the sorting ability of Zambian and Scottish children with objects and pictures of the objects yielded similar findings.[38] Sorting with real objects showed no difference between the two cultural groups, but the Scottish group was more successful sorting with pictures.

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[36] I.E. Sigel, "The Distancing Hypothesis: A Causal Hypothesis for the Acquisition of Representational Thought." Paper delivered at University of Miami Symposium on the effects of early experience, 1968. Cited in Deregowski, "Responses Mediating Pictorial Recognition," p. 28.

[37] Deregowski, "Responses Mediating Pictorial Recognition."

It appears, then, that in addition to within-the-picture difficulties of recognizing depicted objects and comprehending the spatial relationships among them, there may be culturally influenced differences in manipulating drawings as symbolic representations. From the evidence gathered so far it is difficult to determine whether the problems of symbolic manipulation, what we may call thinking with the language of pictures, are the result of real cultural differences in conceptual ability or only reflect a lack of experience in dealing with pictorial material.

Reasons for Cross-Cultural Differences

The fact that different cultures respond to pictures differently is more easily determined than why their responses differ. A number of interesting hypotheses have been put forward along with substantiating evidence, but as in the case of susceptibility to visual illusions, it is not yet possible to settle upon any single determining factor. Perhaps it comes down to a question of which, among the many factors that have been shown to be influential, are the most important.

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[38] Jan B. Deregowski and R. Serpell, "Performance on a Sorting Task: A Cross-Cultural Experiment," International Journal of Psychology, 6, 1971, pp. 273-281.

Cultural stimulation, schooling and intelligence

Hudson focused attention on the role of perceptual habit in the interpretation of pictorial material. Western culture, he suggests, is book-learned and characterized by dependence upon the written word, illustration, diagram and photograph.[39] Certain perceptual habits have become normal for Western culture and for groups professing it. Mundy-Castle also gave preeminence to the role of cultural stimulation in attaining familiarity with pictorial material. This familiarity derives from "such cultural products as pictures, posters, photographs, movies, television and activities such as drawing, painting and the playing of games wich pictorial content."[40] Hudson found that intelligence as measured by IQ tests was also a factor which affected pictorial depth perception but only with white school-going samples.[41] Without the appropriate pictorial experience, intelligence seemed to make no difference. Similarly, regarding educational level, Hudson found that depth perception among white primary school groups occurred more frequently the higher the educational standard but that educational level had little effect on the performance of black samples. Of particular interest was his finding that certain African university graduates with high intelligence and education interpreted pictorial material two-dimensionally. Therefore, although intelligence and education were found to be factors affecting picture perception, their influence was only secondary and depended upon sufficient familiarity. Hudson summed up his findings with regard to the roles of education and intelligence as follows:

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[39] Hudson, "Pictorial Depth Perception . . . ," p. 185.

[40] Mundy-Castle, "Pictorial Depth Perception . . . ," p. 117.

[41] Hudson, "Pictorial Depth Perception . . . ," pp. 197-206.

> In a cultural group that has a normal range of intelligence, that in addition possesses high educational qualifications but that is isolated from the dominant cultural norm, pictorial depth perception is not closely related to intellectual endowment or educational achievement. The critical threshold is cultural, and not educational.[42]

Socialization practices

Vernon found that Ugandan school boys tested poorly on a Picture Recognition Test, which included several of Hudson's drawings, as well as on a Kohs Blocks Test.[43] In the latter he found that the majority could copy block models, but were incapable of transferring printed designs to the blocks. Many were also satisfied with false solutions. However, the Ugandan boys scored well on two paper and pencil tests that normally test the same kinds of abilities. Vernon rejected an explanation based on lack of familiarity with pictorial material as an Eskimo sample, for which the same would be true, scored very well on both the Picture Recognition and the Kohs Blocks Tests. He similarly found the "uncarpentered" African environment insufficient to explain the poor Ugandan performance,as most of his subjects were reared in townhouses with rectangular rooms, windows and some furnishings.

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[42] W. Hudson, "Pictorial Perception and Educational Adaptation in Africa," Psychologia Africana, 9, 1962, pp. 226-239. Cited in Dawson, "Cultural and Physiological Influences upon Spatial-Perceptual Processes in West Africa--Part I," p. 116.

[43] Philip E. Vernon, "Abilities and Educational Attainment in an East African Environment," Journal of Special Education, 1, 1967, pp. 335-45. Reprinted in Price-Williams, Cross-Cultural Studies, pp. 76-91.

> More plausible, perhaps, is the suggestion that most African babies are bound to and carried on their mothers' backs for the first year or two; hence not only is their vision restricted (largely to a rounded object), but also they obtain very little manipulative or kinesthetic experience. To this the writer would add the inadequacies of psychomotor experience throughout childhood and the absence of interest in constructive play or of cultural pressures to practical achievements. Few homes would provide knives and forks, doorknobs, scissors, buttons, pencils or toy objects to manipulate, and African parents seem more apt to frustrate than to encourage curiosity and exploratory activities or to reward the acquisition of skills. Thus to a remarkable extent preschool children are content just to sit doing nothing, and they are notably passive and submissive when school attendance starts.[44]

Herman Witkin was one of the first to specify socialization practices as a factor bearing on perceptual processes both between cultures and within cultures. Witkin found that various indicators of psychological differentiation tend to cluster together, suggesting that they are not discrete abilities but rather diverse expressions of a single underlying orientation that a person brings to bear on intellectual, perceptual and emotional problems. He calls these forms of psychological functioning "cognitive styles" and describes them as the

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[44] Vernon, "Abilities and Educational Attainment . . . ," p. 85.

"characteristic self-consistent modes of functioning found pervasively throughout an individual's cognitive, that is, perceptual and intellectual, activities."[45] In particular Witkin focused attention on the global-articulated dimension of cognitive functioning. This refers to the degree to which people are able to extract an item from its context.

> Progress from global to articulated, which comes about with growth, occurs not only in perception, where we are dealing with an immediately present stimulus configuration, but in thinking as well, where symbolic representations are involved. Articulated experience is a sign of developed differentiation in the cognitive sphere.[46]

An articulated cognitive style is distinguished by an analytic approach to perceptual discrimination and by other psychological characteristics such as an articulated body concept and a sense of separate identity. A person with a relatively global cognitive style, on the other hand, will function less analytically in perceptual problems and will have a limited sense of separate identity. A global cognitive style is considered to be "self-centered" as opposed to the "stimulus-centered" character of the articulated style.

Witkin has found that tests of field-dependence show a high correlation with the global-articulated dimension of cognitive style, field-independent people being more highly differentiated than field-dependent ones.

> In a field-dependent mode of perception the organization of the field as a whole dominates perception of its parts; an item within a field is experienced as fused with the organized ground. In a field-independent mode of perception, the person

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[45] Herman A. Witkin, "Cognitive Styles Across Cultures," International Journal of Psychology, 2, No. 4, 1967, p. 234.

[46] Witkin, "Cognitive Styles . . . ," p. 234.

> is able to perceive items as discrete from the organized field of which they are a part. The field-dependence-independence dimension is a continuous one, most persons falling between these two extremes.[47]

In order to test field-dependence Witkin developed an Embedded Figures Test, a Rod-and-Frame Test and a Body Adjustment Test. He has also found that Kohs Blocks and Figure Drawing Tests are reliable measures of field-dependence.

Witkin has demonstrated that lack of differentiation is directly related to restrictiveness in child-rearing practices. Harsh punishment produces conformist children who are often found to lack skills related to visual analysis. Mothers of field-dependent sons are often dominating and anxious, while fathers are passive and usually inadequate as role models. Children who are treated less harshly and have been encouraged to explore develop more analytic, independent perceptual styles. Among Western subjects Witkin found consistent intersexual differences and suggested that in Western cultures girls were socialized more restrictively, resulting in a more global cognitive style.

Dawson, using Witkin's theory, sought to explain why African subjects with high education and intelligence as well as experience in a carpentered world should still have difficulty with spatial-perceptual tasks, maps, pictures and diagrams.[48] Might there be a limiting spatial-perceptual factor deriving from certain aspects of the African environment which might influence individual adaptation to urban situations? He compared the performance of Temne and Mende subjects in Sierra Leone on a number of perceptual tasks, including Kohs blocks, Embedded Figures and a test of pictorial depth perception which utilized several of Hudson's drawings. The main variable between the two tribal groups was their different socialization practices. Temne tribal values are much more aggressive than the Western type values of the Mende. The Temne mother is dominating and discipline in the home is strict. The Mende have much less severe socialization practices and individual initiative is encouraged. Dawson hypothesized that these differences in child-rearing practices would be likely to develop a more global and field-dependent cognitive style in the adult Temne male than in his Mende counterpart. Dawson's findings confirmed his hypothesis, the Temne males showing significantly more field-dependent characteristics than the Mende. He also found that pictorial depth perception was closely related to the field-dependence variable, the Temne having significantly lower scores than the Mende. Furthermore, within each group, depth perception scores were lowest for those subjects who considered their mothers to have been very strict.

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[47] Ibid., p. 236.

[48] John L.M. Dawson, "Cultural and Physiological Influences upon Spatial-Perceptual Processes in West Africa--Part I," International Journal of Psychology, 2, No. 2, 1967, pp. 115-128.

Berry tested eight samples of subsistence level peoples in Sierra Leone, New Guinea, Australia, Baffin Island and a control group in Scotland in order to substantiate his hypothesis that spatial perceptual skills develop in a manner that is consistent with ecological demands.[49] He cited evidence to support his premise that in agricultural and pastoral societies there is a strong tendency to emphasize responsibility and obedience during socialization, while in hunting and gathering societies achievement, self-reliance and independence are emphasized. As a result, he suggested, hunting societies should demonstrate more field-independence and more articulated cognitive style than agrarian societies. Using a tachistoscopic test of visual discrimination ability and three tests of spatial skills (Kohs Blocks, Embedded Figures and Ravens Matrices), Berry was able to demonstrate a direct correlation between spatial perceptual skills and the hunting demands typically placed on persons within the eight societies examined.

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[49] Berry, "Ecological and Cultural Factors in Spatial Perceptual Development."

Dawson submitted to factor analysis a number of variables which had emerged throughout his Sierra Leone study as being associated with field-dependence.[50] As previously stated, he found that the pictorial depth perception variable loaded highly on the field-dependence factor.

> The high loading of 3D on this factor indicates as expected that this test involves a perceptual task the solution of which is facilitated by Ss in the sample who have a more masculine field independent perceptual style.[51]

A correlational analysis was carried out in order to compare Hudson's findings on pictorial perception with the variables contributing to Dawson's field-dependence factor. Depth perception correlated with both education and intelligence indicating that these were significant variables in the acquisition of pictorial cues. However, a much more significant correlation with the Kohs Blocks and the Embedded Figures

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[50] John L.M. Dawson, "Cultural and Physiological Influences upon Spatial-Perceptual Processes in West Africa--Part II," International Journal of Psychology, 2, No. 3, 1967, pp. 171-185.

[51] Ibid., p. 177.

Tests showed that field dependence was a more critical variable. Dawson suggests:

> On the basis of these findings it was not considered as Hudson suggested that "exposure to specific experience" was a crucial variable over and above education and intelligence, as it could hardly be argued that university graduates have not been exposed to "specific experience."[52]

As further evidence, Dawson cites a relatively low correlation between depth perception and a T-W Scale used to measure traditional versus Western environmental experience,and an almost negligible though positive correlation with a measure of whether subjects have come from a village, a small town or a larger town. Dawson concludes:

> The lower T-W Scale and educational loadings on the field-dependence factor would likewise argue against "exposure" being the crucial variable. However, it is not suggested that contact with "specific experience" is not a relevant variable. From the results set out it is apparent that it is a necessary step in the overall process. What is suggested on the basis of these results is that the extent to which an individual is able to make use of this environmental experience and acquire perceptual cues, is in part in Sierra Leone a function of his field-independence potential.[53]

The research evidence to date seems to indicate that no single factor is responsible for cross-cultural differences in ability to understand pictorial material. Certainly exposure to pictures either formally or informally is a basic prerequisite as Hudson and Mundy-Castle have demonstrated. Perhaps in the West, where pictorial stimulation is so ubiquitous, exposure alone is sufficient to make every person a fairly competent picture perceiver. In rural areas, however, where literacy and printed material have only recently been introduced,

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[52] Dawson, "Cultural and Physiological Influences . . . ," p. 181.

[53] Ibid., p. 182.

Dawson has shown that an analytic perceptual style greatly facilitates a person's ability to make use of the more limited exposure to pictorial experiences. A person's cognitive style, in turn, has been shown to be affected by socialization (Witkin) and by ecological factors such as whether the population is engaged in hunting or agriculture (Berry). Vernon, furthermore, suggests that a lack of kinesthetic and psychomotor experience during early childhood may be responsible for the poor spatial and pictorial abilities among many cultural groups. We have also seen that where exposure to pictorial experiences is adequate, intelligence and educational level will become significant factors (Hudson, Dawson).

All of these considerations suggest a possible hierarchy or order of priorities that may prevail in the acquisition of pictorial abilities in technologically developing societies. At the top of the list is exposure to pictorial material, either informally or through instruction, without which the other elements appear to have little effect. An analytic cognitive style seems to be the next most important factor that will lead to pictorial understanding. Dawson would put this first, saying that without an analytic perceptual style the exposure would have little effect, the African college students who are two-dimensional perceivers being a case in point. However, in Western society even people with the most global perceptual style can still become fairly sophisticated in looking at pictures. Therefore, we would put analytic ability second to exposure. Only where these two conditions already prevail do intelligence, as measured by IQ tests, and years of education appear to become significant variables.

The picture becomes more complicated when we consider the factors contributing to cognitive style. Adequate psychomotor activity and manipulative experience in early childhood is probably the most important variable. This greatly depends upon child-rearing practices, and these, in turn, appear to be influenced by ecological factors such as the group's primary method of gathering food or its degree of acculturation. The major variables in order of their apparent importance are summarized in Table 2.

TABLE 2

FACTORS MENTIONED IN THE CROSS-CULTURAL LITERATURE AS HAVING INFLUENCE ON PICTURE PERCEPTION, LISTED IN ORDER OF IMPORTANCE

I. Exposure

    (a) acculturation
    (b) training

II. Analytic perceptual style

    (a) psychomotor experience
    (b) child-rearing practices
    (c) ecology

III. Intelligence and education

All of these may have bearing on the possibility of communicating effectively with villagers through pictures.

Teaching Experiments and Applied Research

In the studies cited so far, the evidence for environmental determination in the development of pictorial abilities as opposed to genetic factors, has been largely circumstantial rather than direct. We have seen that pictorial depth perception is in part a function of both exposure to appropriate experiences and of an articulated perceptual style, and to a lesser degree a question of intelligence and education. What evidence do we have that genetic endowment is not also a factor in culturally patterned responses to pictures?

D'Andrade tested first grade Hausa children in northern Nigeria with Kohs Blocks and found they performed poorly compared to Western norms.[54] By carefully observing their mistakes he was able to design a "programmed instruction" procedure that brought them up to Western levels. D'Andrade felt that the children's poor initial performance was due to lack of familiarity with drawings and with any type of pictorial representation. Hausa children, he noted, rarely see pictures of any type, let alone use pictures as a "blueprint" for any kind of action. Even adults and university students are baffled by maps and diagrams. D'Andrade felt that the skills involved in the Kohs Blocks Test, whether perceptual or cognitive, were "rapidly modifiable when the proper conditions for new learning are found."[55]

Duncan, Gourlay and Hudson have reported successful results in teaching depth cues with the use of a portable viewing window.[56] The subject views a three-dimensional scene through a pane of glass and outlines the main elements with washable paint or grease pencil. Other participants can cooperate by standing at various distances away while the outline is being drawn. A piece of white paper can be put behind the glass and the result is a simple outline drawing on a flat surface. Cues of perspective and depth such as overlap and relative size can be pointed out.

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[54] R.G. D'Andrade, "Testing and Training Procedures at Bassawa," Paper 4, Institute of Education, Almadu Bello University, 1967 (mimeographed). Cited in Robert A. LeVine, "Cross-Cultural Study in Child Psychology," in Paul H. Mussen (ed.), Carmichael's Manual of Child Psychology, 2, Third edition (New York: John Wiley and Sons, Inc., 1970), p. 578.

[55] D'Andrade, "Testing and Training Procedures . . . ," p. 578.

[56] Duncan, Gourlay and Hudson, "A Study of Pictorial Perception . . . ," pp. 168-182.

Dawson carried out a teaching experiment using a similar technique.[57] A control and a study group were matched for intelligence, education, occupation, age, sex, tribe and field-dependence. All subjects were two-dimensional perceivers. Both groups were required to sketch from colored photographs, but the study group was also trained in the use of pictorial depth cues during eight weekly one hour sessions. Three months later the two groups were retested. The study group showed a significant enduring improvement in pictorial depth perception over the control group.

Studies by Winter and Hudson explored the effectiveness of safety posters designed with didactic objectives in mind.[58] One set of posters consisted of causal scenes of the "before and after" type. Scenes were arranged either horizontally or vertically. In either case, the black factory workers had difficulty associating the man in the "before" scene with the same man in the "after" scene. The situation and dress were different and there were no identification clues.

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[57] Dawson, "Cultural and Physiological Influences . . . ," Part I.

[58] Hudson, "The Study of the Problem of Pictorial Perception."

Another poster was designed to illustrate the danger of throwing tools. A hammer was shown striking another worker on the head. But being mostly two-dimensional perceivers, the workers reported the hammer to be lying on a window sill rather than flying through mid-air and the prime cue of the poster was missed. Another poster, intended to illustrate the concept of cooperation, depicted the dilemma of two calves tied together and faced with the problem of drinking milk from two buckets set further apart than the length of their rope. Hudson reports some of the misinterpretations of this poster: "It teaches me how to attend cattle," "It shows me how to feed calves," "It tells me to rest and drink when I'm tired," "It tells me to work like cattle." The purpose of each poster (sixteen in all were studied by Winter and Hudson) was to communicate a specific message. Hudson concluded that "colored geometric patterns would have made just as suitable posters and would have been nearly as effective communicators."[59]

Among the general findings derived from these studies Hudson recommends designing single-scene in preference to multi-scene posters. Captions, he found, made little difference, as most of the labor force tested could not read well. Oral explanations, however, increased understanding by fifty percent. He found that depth cues caused confusion, and symbolic conventions such as stars to indicate impact were taken literally. Too much detail or undue economy of presentation were both detrimental to understanding. When the posters were redesigned, only single scenes were used. Background and unnecessary details were removed. Great care was taken to show that the worker in the picture possessed all his limbs and fingers even if this meant the loss of perspective and foreshortening.

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[59] Hudson, "The Study of the Problem of Pictorial Perception," p. 153.

Hudson also found that what can be pictorially meaningful at one level can be meaningless at a lower level of acculturation. Supervisors showed more understanding than did the experienced workers or the raw recruits. Thus, he suggests, at the present time no one mode of representation will suffice. Pictorial representation will have to be diversified until such time as by a common educational process perceptual homogeneity can be reached. He concludes:

> Provided pictorial material appropriately designed for acculturation level and conceived as a visual aid and not as an independent technique, plays a role in the preparation of the pupil, it is worth the cost of time, effort and money.[60]

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[60] Hudson, "The Study of the Problem of Pictorial Perception," p. 156.

CHAPTER III

THE NATURE OF INTELLIGENCE AND SOME IMPLICATIONS FOR DEVELOPMENT EDUCATION

We have examined at length the language of pictorial communication and some of the problems involved in graphic representations. But perception is only the first step in the process of "decoding" pictorial messages. Much of the information transmitted for development work is technical, pertaining to problems of agriculture, nutrition, sanitation, family planning, and so forth. Development messages are often formulated at a sophisticated level, employing abstract and scientific concepts. It is important to know whether the village people have the conceptual as well as the perceptual tools to "decode" the messages. What assumptions can we make about their understanding of physical cause and effect or of other logical relationships? What can we say about the nature of peasant "intelligence"?

We have seen that a child of nineteen months was able to identify pictures of familiar objects without any training or previous exposure. But M.D. Vernon points out that if a picture has "meaning" in the sense of suggesting events not actually depicted, the child may not be able to grasp this until he is about eleven years old. The Terman-Merrill intelligence test, for example, contains a picture of a telegraph boy whose bicycle wheel has come off. He is waving to a car to stop and give him a lift. The average child is unable to give this meaning until he is approximately twelve.[1] We can see that in addition to the perceptual aspects of pictorial communication there are cognitive aspects that also require investigation.

Current Theories of Intelligence

The idea of intelligence conjures up different meanings to different people. To one it refers to a person's innate capacity which he has inherited from his forefathers and which determines the mental growth he is capable of. To another it means a person's mental efficiency, his ability to reason and comprehend. To yet a third it signifies a person's mental age as measured by an intelligence test. Philip Vernon has labelled these three conceptions Intelligence A, B, and C respectively.[2] The distinction between Intelligence A and B was first pointed out by Hebb. Intelligence A is the child's inherited potentiality for mental growth and it cannot be observed directly. It was erroneously thought at one time that Intelligence C, the IQ test, was an index of Intelligence A, but that view has been widely criticized. Studies of children brought up in favorable and unfavorable circumstances, of twins and of foster children, demonstrated that environmental effects on test performance were considerable. It seemed more likely that the IQ tests were a measure of Intelligence B. Intelligence B, according to Vernon and Hebb, is the product of both nature and nurture. It is not static or fixed, nor is it a universal faculty which is found in more or less quantity in all cultural groups. Describing Intelligence B, Vernon writes:

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[1] M.D. Vernon, The Psychology of Perception (Harmondsworth: Penguin Books, Ltd., 1962), pp. 102-103.

[2] Philip E. Vernon, Intelligence and Cultural Environment (London: Methuen and Co., Ltd., 1969), pp. 9-10.

> Clearly it develops differently in different physical and cultural environments. It should be regarded as a name for all the various cognitive skills which are developed in, and valued by, the group. In Western civilization it refers mainly to grasping relations and symbolic thinking, and this permeates to some extent all the abilities we show at school, at work, or in daily life. We naturally tend to evaluate the intelligence of other ethnic groups on the same criteria, though it would surely be more psychologically sound to recognize that such groups require, and stimulate, the growth of different mental as well as physical skills for coping with their particular environments, i.e., that they possess different intelligences.[3]

The evolution of the idea of intelligence

During the first half of the century intelligence was generally regarded as a unitary faculty that was for the most part determined by heredity. The most persistent legacies of this view have been the idea of a general mental power underlying all intellectual activities, which Spearman called g, and the IQ scale with its single numerical score. Spearman felt that the universal factor was innate and uneducable. It was portrayed as a kind of general mental energy with which each individual was endowed. In addition to the g factor Spearman postulated s factors, which were specific to each act. They were like machines which were powered by the general mental energy. These machines were the specific abilities that each individual develops. They could be improved by education and training.

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[3] Vernon, Intelligence and Cultural Environment, p. 10.

Spearman's two factor model, however, was unable to account for the great diversity of findings about human intelligence. In the first place, many of the intelligence tests failed to correlate with one another and individuals often showed obvious unevenness in intellectual functioning. Furthermore, various intellectual abilities were found to develop and decline at different rates; people with brain injuries were affected in some areas of thinking but not in others; a person who was considered a prodigy in one field would display unaccountable lapses in another. Using the techniques of test intercorrelations and factor analysis, British psychologists such as Cyril Burt and Philip Vernon began to fill out Spearman's model with "group factors." They developed hierarchical models of intelligence which divided broadly into scholastic and practical abilities. These broad categories further subdivided into verbal and numerical skills on the one hand and spatial and mechanical skills on the other and these, in turn, broke down into more specific group factors, and so forth.[4] Burt and Vernon continued, however, to place high priority on a g factor which exerted its influence throughout their models.

At the same time, American psychologists such as L.L. Thurstone and more recently J.P. Guilford began to break entirely with Spearman's approach by eliminating the g factor altogether. Thurstone separated intelligence into eight Primary Mental Abilities which he identified as verbal comprehension, verbal fluency, memory functions, spatial relations, perceptual speed, inductive and deductive reasoning. Guilford has gone even further, postulating a model of 120 interrelated but separate and unique intellectual factors of which he claims to have found evidence for more than eighty.[5] These recent approaches describe intelligence in terms of a profile rather than a single score. Even the standard IQ tests have begun to distinguish between verbal and practical abilities and to reflect the growing acceptance of differential abilities in intellectual functioning. Today the multiple nature of human intelligence has been generally recognized.

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[4] Philip E. Vernon, The Structure of Human Abilities (London: Methuen and Co., Ltd., 1950).

In light of these findings it should be expected that unacculturated groups will perform unevenly on tests developed to assess Intelligence B in Western societies. In contrast to an overall "ability theory" which would have certain cultural groups developing for various reasons more powerful intellects in general, Michael Cole and his associates have proposed the notion of "culture specific skills."[6] People seem to be good at doing the things that are important to them and that they have occasion to do often. Primitive cultures simply make different sorts of intellectual demands than technologically advanced ones. For example, Cole found that Kpelle people are exceptionally good at estimating various amounts of rice, but inaccurate and inconsistent in estimating lengths. Cross-cultural findings such as these tend to substantiate the multiple ability view of intelligence. Cole and his associates see no justification for the conclusion that cultural differences in test performance are a sign of any general mental deficit. Rather the observed differences are the result of situational factors. They suggest that

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[5] J.P. Guilford, The Nature of Human Intelligence (New York: McGraw-Hill, 1967).

[6] Michael Cole, John Gay, Joseph A. Glick, Donald W. Sharp, et al., The Cultural Context of Learning and Thinking: An Exploration in Experimental Anthropology (New York: Basic Books, 1971).

> cultural differences in cognition reside more in the situations to which particular cognitive processes are applied than in the existence of a process in one cultural group and its absence in another.[7]

If, for example, illiterate subjects reflect "situation bound" thinking, Cole and his associates are unwilling to accept the inference that nonliterate villagers are unable to reason hypothetically. Rather villagers fail to see the applicability of such reasoning in the experimental task. We shall examine more closely how tenable this position is when we look at the developmental approaches to intelligence. A similar view, however, was expressed by UNESCO in 1951:

> According to present knowledge there is no proof that the groups of mankind differ in their innate mental characteristics, whether in respect of intelligence or temperament. The scientific evidence indicates that the range of mental capacities in all ethnic groups is much the same.[8]

Vernon points out that there is also no proof that innate mental differences do not exist and in fact there is evidence for genetic differences which cannot be ignored.[9] He cites among other things the small but significant correlations between the intelligence of foster children or orphans and their true parents; the differences in IQ between siblings that could not reasonably be accounted for by differences of upbringing; and the extreme difficulty in raising the IQ of dull children no matter how stimulating the environment. The possibility of genetic differences in the mental capacity of various ethnic groups cannot at present be proved one way or another, but probably the influence is small compared to such cultural factors as language, nutrition and socialization practices. Cross-cultural studies for the most part take the approach that intelligence derives from a process of interaction between hereditary and environmental factors; in other words, they are concerned with the development of Intelligence B.

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[7] Ibid., p. 233.

[8] Cited in Vernon, Intelligence and Cultural Environment, p. 12.

[9] Ibid., p. 13.

Developmental approaches

It is generally accepted today that cognitive development is a process of adaptation which begins with the initial sensory-motor reflexes of the newborn infant and, through a combination of maturation and interaction with the environment, proceeds gradually to the increasingly complex cognitive skills of adult intelligence. Hunt describes intelligence as "problem-solving capacity based on a hierarchical organization of symbolic representations and information processing strategies deriving to a considerable degree from past experience."[10] A series of successive stages or mental reorganizations characterizes the growing child's perception, language and thought, each child moving through this sequence at his own rate.

The clearest picture of intellectual development to date has come from the research of Piaget and his associates. According to Piaget there are four factors that shape the process of development:

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[10] J. McVicker Hunt, Intelligence and Experience (New York: The Ronald Press Co., 1961), p. 109.

biological factors, equilibration factors, socio-cultural factors and educational factors.[11] The maturation of the nervous system is one of the biological factors and probably accounts for the sequential order of the stages of development. Biological factors may also set the limits of a person's ultimate mental capacity, but as we have seen, this has yet to be demonstrated. Equilibration factors give structure to the developing intelligence by providing the self regulations that enable it to adapt to internal and external changes. Intelligence functions as a process of organization which is constantly assimilating the new to the old and accommodating the old to the new, seeking higher and higher states of equilibrium. The child gradually becomes capable of taking account of stimuli more and more remote in space and time and of resorting to more and more indirect modes of problem-solving. Interaction with the physical and social environment is critical in the development of intelligence and comprises the socio-cultural factors. Piaget maintains that every cognitive ability is to some extent a form of internalized activity. Manipulating real objects, ordering them, rotating them, watching them float or sink, is the first step in representing them mentally. In the same way, in all societies children ask questions, work together, exchange information and model the behavior of their elders. Although sociocultural factors will vary to some degree from culture to culture, the basic processes of interaction are common to all, and should, in the end, lead to the final equilibrium state which is logical thinking. The degree to which all societies foster logical thinking, however, is a question for cross-cultural investigation. Similarly, educational factors will vary from culture to culture and another area for cross-cultural research is to determine the influence of specific modes of cultural transmission, such as language, on concept formation. Does language in any way shape the content of classifications or of relations as the Sapir-Whorf hypothesis claims?

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[11] Jean Piaget, "The Need and Significance of Cross-Cultural Studies in Genetic Psychology," International Journal of Psychology, 1, No. 1, 1966, pp. 3-13. Reprinted in Berry and Dasen, Culture and Cognition, pp. 299-309.

According to Piaget, intelligence does not simply become better and better in a continuous way. Development takes place in stages, which are qualitative structural changes, and the relationship between successive stages is hierarchical. The structures of earlier stages become incorporated into those of the subsequent ones. Piaget divides intellectual development into four periods. The sensori-motor period, lasting from birth until approximately two years, is characterized by a practical intelligence similar in quality to the action intelligence of animals. The pre-operational stage, from two to about seven, is marked by the increasing internalization of action resulting in the development of symbolic thinking as in make-believe play. It is also a time of rapid language growth. During the period of concrete operations, which lasts from seven to about eleven, the child learns to apply logical thought to concrete problems. Finally, during the period of formal operations, from eleven to approximately fifteen, the child's cognitive structures reach maturity and he becomes capable of treating all classes of problems logically, including those that are purely verbal and those that are hypothetical. The equilibrium condition of each stage implies an integrated whole. In this way it is possible to interpret a wide range of seemingly unrelated behaviors in terms of one underlying structural totality. The biological and equilibration factors assure that the sequence of stages is invariant. However, the age at which a given stage is reached may vary considerably as may the ultimate degree of advancement along the developmental continuum. Piaget himself hypothesized on the evidence of some of the early cross-cultural investigations of his theory that

> . . . it is quite possible (and it is the impression given by the known ethnographic literature) that in numerous cultures adult thinking does not proceed beyond the level of concrete operations, and does not reach that of propositional operations, elaborated between 12 and 15 years of age in our culture.[12]

If this is true, it is not likely that people who are in the concrete operational stage will be capable of hypothetical thinking, which does not emerge until the onset of formal operations. Although the "situation bound" thinking of illiterate villagers may not signify any general mental deficit, it probably does indicate that they are functioning at a cognitive level that is below their potential.

Bruner, like Piaget, sees mental development as proceeding through qualitatively different stages. He has distinguished three modes of processing information which he calls enactive, iconic and symbolic. Each of these modes is characterized by particular techniques of transmission which correspond to the developing organism's capacity for representing the world. Enactive functioning involves adaptation at the sensori-motor level, learning through direct experience. Iconic learning is through observation and modeling. Even the more intelligent animals are capable to a limited degree of this kind of learning. Bruner cites the example of two groups of cats that learned to pull strings and open doors by observing other cats.[13] Learning through symbolically coded experience, however, is seen as a distinctive characteristic of the human species. Symbolic learning is associated with language, the development of literacy and of other symbolic codes (including pictures). Each culture assists its members to develop these powers by providing amplification systems to which human beings, equipped with appropriate skills can link themselves.[14] The first level of amplifiers extends our capabilities in the realm of action and includes tools, such as hammers, levers and wheels. Secondly, there are amplifiers of the senses, ranging from smoke signals and pictures to microscopes. The most powerful amplifiers, however, are those of the thought processes, including language, mathematics and logic. Each culture is a repository and transmitter of amplification systems, and Bruner believes that cognitive development depends to a large degree on the supply of amplifiers a culture has in stock, the nature of the demands placed on the individual by the kind of life he leads, and the extent to which the individual has opportunity and is encouraged to explore the three modes of learning.[15] In less technical societies children learn more by doing and by modeling than through any overt instruction. Therefore there are fewer compelling reasons to connect events to anything beyond their immediate contextual settings. A major difference between a technical society and an indigenous one, Bruner feels, is the institution of the school. Whereas cultural transmission in traditional societies is always in the context of action, the school converts knowledge and skill into more symbolical, abstract and verbal form.[16] We will return to this theme after briefly examining some of the findings of cross-cultural research in cognition.

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[12] Berry and Dasen, Culture and Cognition, p. 309.

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[13] Jerome S. Bruner and David R. Olson, "Learning Through Experience and Learning Through Media," Prospects (UNESCO), 3, No. 1, 1973, p. 24.

[14] Jerome S. Bruner, "The Growth of Mind," American Psychologist, 20, No. 12, 1965, p. 1009.

Cross-Cultural Investigations

The problem of ethnocentrism hangs over the cross-cultural study of intelligence like a sword of Damocles. The modern intelligence test was originated at the beginning of the century by Alfred Binet as a way to predict school success in France. It would be difficult to say what could be learned from the performance of other cultural groups on such tests. Perhaps a valid comparison of individuals *within* a homogeneous sub-cultural group could be made, but comparisons *between* cultural groups would be difficult to interpret. The "ethnoscience" approach to cross-cultural comparisons, advocated by Berry, Wober, Sturtevant and others, suggests that rather than asking "How well can they do our tricks?" we should ask "How well do they do their tricks?"[17] The difficulty with this method is that cross-cultural comparisons are only valid if it can be demonstrated the task is functionally equivalent in each culture tested. A simpler and more feasible approach takes the premise that the crux of "culture fair" or "culture free" testing lies in the subject's familiarity with the test materials.

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[15] J.S. Bruner, R. Olver, P.M. Greenfield, *Studies in Cognitive Growth* (New York: Wiley and Sons, 1966), Chapter 14.

[16] Bruner, "The Growth of Mind," p. 1009.

Classification studies

We will begin by describing two classic studies of equivalence grouping, one carried out in rural Senegal by Greenfield, Reich and Olver and the other in Nigeria by Price-Williams. Equivalence grouping is considered to be an indication of ability to carry out abstract thinking. The assumption has generally been that Western children are able to isolate qualities and to synthesize them into generalizations. Their thinking is "abstract." Rural village children, on the other hand, have difficulty detaching themselves from the object's unique perceptible attributes and therefore they fail to see that the object is a representative of a class. The attributes cannot be separated from their context and dealt with independently. The thinking of village children is "concrete."

It has been noted that the Western child begins by forming "complexive groupings" that share no common attribute and where only perceptible concrete characteristics such as color, shape or texture, are utilized.[18] An example of complexive grouping would be edge matching: "The orange and the apple are alike because they are round; the potato and the orange have these little dents; the potato and the fish are brown," etc. Complexive thinking shows an overabundance of connection and a weakness in abstraction. Steps toward abstraction include grouping objects that are maximally similar and eventually on the basis of a single attribute. A concept emerges when the abstracted traits are synthesized and the synthesis becomes the main instrument of thought. Concept formation is more than associative bonds, and it cannot be taught by drilling. It is a genuine act of thought. According to Piaget, conceptual groupings are an indication of concrete operational ability. As the child grows older the basis of his groupings begins to shift from perceptible to functional and nominal attributes ("We can eat them" or "They're all foods."). Nominal groupings require a symbolic transformation from criterial attributes to a class name. When all members of a collection have one or more attributes in common they are said to constitute a superordinate group. Superordinate groupings generally increase with age.

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[17] J.W. Berry, "Radical Cultural Relativism and the Concept of Intelligence," in Berry and Dasen (eds.), Culture and Cognition, p. 227.

Greenfield and her associates compared the performance of Wolof children in Senegal with North American children. Three groups of Wolof children, each ranging in age from six to sixteen, were tested. Two of the groups were village children, one attending a local school and the other with no exposure to schooling; the third group attended school in the fairly cosmopolitan city of Dakar. The array included four articles of clothing, four round objects and four red things, so that groupings could be made by function, form or color. It was postulated that any grouping that resulted from correctly applying a rule, one or more attributes being common to all items, would constitute a true superordinate concept.

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[18] Patricia Greenfield, Lee Reich, and Rose Olver, "On Culture and Equivalence: II," in Bruner et al., Studies in Cognitive Growth, Chapter 13.

The authors were astonished by the results of their tests. The unschooled Wolof children were able to group objects by the superordinate ideal of a single attribute, color, from six years old, while the school children's choices at that age were typically characterized by the shifting attributes of complexive structures. This meant that the seemingly precocious unschooled Wolof children selected superordinate groupings earlier than suburban North American children. But the testing further showed that the only change in grouping structure with age among the unschooled Wolof consisted of learning to apply the color rule more and more systematically, while the school children turned increasingly with age to form and function as reasons for classification. These findings led the authors to conclude that the complexive stage may not be part of a natural process of maturation but a special adaptation brought forth by the demands of the environment, most notably school.

> It may be that such environments demand the diversification of classificatory bases and initially this multiplicity of types of attributes entails that inefficient grouping structure called complexive. The complex may be a necessary step preliminary to the ultimate accomplishment of equivalence groupings on a variety of criterial attributes.[19]

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[19] Greenfield, Reich, and Olver, "On Culture and Equivalence," p. 286.

A group of unschooled adults was also tested and the only difference between the adults and the unschooled children was that the adults were better at doing the same thing, classifying by color. The unschooled Wolof children failed to make a single functional grouping and the authors concluded that without training in classification or some other aspect of the school experience, this ability fails to develop among Wolof children. Even the complexive precursor was absent. The rural schoolchildren, on the other hand, were more similar to the city Wolof schoolchildren and even to American suburban children, at least in their approach to equivalence grouping, than they were to their unschooled brothers and sisters in their own village.

Price-Williams used a more "ecological" approach in studying classificatory abilities among Tiv children in Nigeria.[20] The Tiv are a tribe of subsistence level farmers whose interests lie in animals, plants and agricultural matters. The materials used for the research were toy animals and plants gathered locally, all of which were familiar to the subjects. Price-Williams compared the performance of literate and illiterate children ranging in age from approximately six to eleven. A collection of either plants or animals was put in front of the child and he was asked to put into rows the ones that belonged together. Subjects were asked to do this in as many ways as they could, based on the assumption that the ability to "shift," that is to select alternative ways of classification, is a measure of ability to abstract. Reasons for grouping were graded on a qualitative scale ranging from concrete to abstract. Responses based on immediate sensory impressions such as color, shape or size were considered concrete. Classifications based on dichotomies such as edible versus inedible, domestic versus wild were considered abstract. Intermediate responses were those exhibiting some attempt to select a common feature from each example in the set, such as the number of legs in the case of the animals; or whether the plant exemplars had roots or not.

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[20] D.R. Price-Williams, "Abstract Concrete Modes of Classification in a Primitive Society," The British Journal of Educational Psychology, 32, 1962, pp. 50-61.

Price-Williams found that in the case of plants, even the youngest group was able to make a functional classification on the basis of edibility at the 85% level. In the case of animals, classification on the basis of domestic versus wild did not begin to emerge until about nine years of age. Price-Williams felt this might be attributable to the fact that there were very few wild animals in the area of the study. The number of classification shifts ranged from approximately three for the youngest group to approximately six for the older children. With both literate and illiterate children there was a tendency for less dependence upon concrete criteria as they grew older. A comparison of the performance of the literate and the illiterate samples also showed hardly any difference in either the number of shifts or in the qualitative scoring of responses. Price-Williams did note a small time lag in the age at which these classification abilities emerged in comparison with European standards. However, his findings on the influence of school differed sharply from those of Greenfield and her associates. Price-Williams states:

> . . . there is no difference between literates and illiterates when not using material upon which the factor of training would be likely to influence differences, i.e., blocks and designs. Using familiar material which they have had an opportunity of manipulating, the evidence suggests that the growth in the capacity to reach the state of "concrete operations" proceeds at a similar rate in both school and illiterate children.[21]

In response to Price-Williams' findings Greenfield and her associates felt that the two experiments were not equivalent. The plants were placed in their appropriate context--an array of plants, requiring only a comparison--whereas the Senegalese experiment used totally arbitrary contexts which the authors felt demanded a higher order concept of similarity.

Conservation studies

Piaget considers conservation to be the sine qua non of the concrete operational period. It refers to the ability to maintain quantitative invariance in the face of changes in appearance. For instance, if water is poured from a tall thin glass to a wide shallow pan, the shape of the water changes to fit the container, but the amount remains the same. To understand that certain perceptible changes in a thing leave other aspects unchanged is an abstraction that must be inferred from experience rather than directly perceived. According to Piaget it is a prerequisite for all logical reasoning. The non-conserver usually focuses on only one dimension of a change, such as the height of water in the container, and is unable to coordinate the complex relationships involved.

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[21] Price-Williams, "Abstract and Concrete Modes . . .," p. 60.

Both Greenfield and Price-Williams carried out conservation experiments as part of their investigations and again, their findings differed dramatically. Greenfield found that both the rural and the city Wolof school children attained conservation of quantity by the eleventh or twelfth year but only half of the unschooled children attained conservation by that age.[22] In fact, the oldest group of unschooled children showed no significant increase over the performance of the unschooled eight to nine year olds. Greenfield concluded that "without school, intellectual development, defined as any qualitative change, ceases shortly after the age of nine."[23] Price-Williams used earth and nuts to test the conservation of continuous and discontinuous quantities among unschooled Tiv children.[24] Virtually all of his subjects were found to be capable of conservation by the age of eight as opposed to only half of the much older Wolof children. But the Tiv culture is very different from the Wolof. Tiv children are encouraged to take an active manipulative approach to their physical environment, while self-initiated, manipulative activity is rarely seen among Wolof children. Greenfield felt that this might explain the disparity in conservation performance between the two cultures.

The studies by Greenfield and Price-Williams are representative of a host of similar investigations on the attainment of concrete operational thinking. In a review of cross-cultural Piagetian research, Dasen considers the evidence in light of four possible outcomes based on the percentage of children attaining the concrete operational stage at each age: (a) the concept develops at the same time as in European children; (b) it develops earlier; (c) it develops later or more slowly, producing a "time lag" in development; (d) the concept starts to develop but the curve flattens out at the higher ages, some children and adults never reaching the concrete operational stage.[25] Only a handful of studies, the one by Price-Williams among them, report conservation as developing at approximately the same time as in European children. There is practically no evidence for earlier development. A great many investigations, on the other hand, report a time lag in development. For example, Greenfield found that the school-going Wolof children had all achieved conservation of quantity by eleven or twelve, whereas this ability is normally attained by eight in Western children. A great many studies also give clear evidence that some subjects, even at the higher ages, never attain the concrete operational stage, as for example, Greenfield's unschooled Wolof children. Dasen states:

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[22] Greenfield, "On Culture and Conservation," in Bruner et al., Studies in Cognitive Growth, Chapter 11.

[23] Ibid., p. 60.

[24] D.R. Price-Williams, "A Study Concerning Concepts of Conservation of Quantities among Primitive Children," Acta Psychologica, 18, 1961, pp. 297-305.

> According to this evidence, it can no longer be assumed that adults of all societies reach the concrete operational stage. However, the cross-cultural differences summarized above are quantitative ones only. It is the rate of development that is in question, not the structure of thinking. As such, the generality of Piaget's system is not threatened. The results simply point to the fact that, among the factors influencing cognitive development, cultural ones might be more impor-

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[25] P.P. Dasen, "Cross-Cultural Piagetian Research: A Summary," Journal of Cross-Cultural Psychology, 3, no. 1, pp. 23-29. Reprinted in Berry and Dasen, Culture and Cognition, pp. 409-423.

> tant than had previously been hypothesized, a possibility that Piaget himself has stressed.[26]

DeLemos tested Aboriginal children on a number of conservation tasks and also found that among the unschooled Aborigines the concept of conservation generally does not develop, although a number of individuals were clear conservers.[27] With regard to qualitative cross-cultural comparisons, Piaget describes three stages in the acquisition of conservation concepts: non-conservation, transitional and conservation. DeLemos was able to clearly distinguish the same three stages in the explanations given by the Aboriginal children.

> Non-conservation responses were invariably justified with reference to the perceptual features of the immediate situation, indicating the child's inability to free himself from his immediate perception, while conservation responses were justified with reference to past or future situations, indicating the child's ability to link these together in a system of reversible transformations.[28]

DeLemos felt the results gave positive evidence that the stages of development described by Piaget are not the product of particular cultural, linguistic or educational factors, but are common to all societies. Studies such as this tend to confirm Piaget's hypothesis that the sequence of development is governed by biological and equilibration factors, while the rate and degree of development are a function of socio-cultural and educational influences.

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[26] P.P. Dasen, "Cross-Cultural Piagetian Research . . .," p. 418.

[27] Marion M. DeLemos, "The Development of Conservation in Aboriginal Children," International Journal of Psychology, 4, No. 4, 1969, pp. 255-269.

[28] Ibid., p. 263.

Factors Influencing Cognitive Growth

Social scientists in the late nineteenth century explained intellectual differences in terms of deficiencies. Herbert Spencer and E.B. Tyler, two of the founding fathers of anthropological theory, applied to sociological and psychological processes the same evolutionary principles that Darwin had used to explain biological processes. They assumed that society evolves from primitive to civilized and that the direction of social evolution was towards the literate and technologically advanced civilization of Western culture. Spencer suggested that the study of less developed cultures would reveal the social and intellectual characteristics of earlier evolutionary forms of human life. Social scientists also borrowed from biology the principle that the anatomical development of the individual organism repeats the development of the species, an idea summed up in the popular aphorism "ontogeny recapitulates phylogeny." Tyler compared the primitive adult to the civilized child, both representing early forms of modern European man.[29]

During the early part of the present century the evolutionary explanations for cultural and cognitive differences came under criticism. In the first place, it became evident that as a result of outside stimulation, or powerful motivation from within, societies were capable of profound technological changes in only a matter of one or two generations. Furthermore, children of "primitive" races who were brought from the colonies and educated in Europe were capable of the same abstract and scientific reasoning processes as their "civilized" classmates. More recent comparative studies have abandoned genetic and evolutionary explanations but a number of psychologists have still sought to demonstrate structural parallels between the thinking processes of primitive adults and Western children. On a developmental continuum the mental process of both groups show a low level of differentiation, articulation and organization. The psychologist Heinz Werner found that the mental organization of children, primitive peoples and certain psychotics was characterized by utilitarian concreteness, syncretism, animism, conservatism and magic. He wrote:

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[29] A review of this literature can be found in Cole et al., The Cultural Context of Learning and Thinking, Chapter 1.

> The reasoning of primitive man, so far as it participates and is embedded in the activity of concrete daily life, exhibits scarcely any difference from that of the man of western culture. It is only in the realm of theoretical reflection, in the seeking for an explanation of natural events in terms of cause and effect, etc., that the essential differences appear. . . . Typical European reflection is universal in nature, abstract; it functions more or less independently of the immediate, concrete reality, and is governed by an awareness of general laws. The thought of primitive man is pinned down to the reality of the thing-like world, and is therefore pragmatic, concrete, individual.[30]

The apparent similarities in the mental organization of primitive adults and civilized children has been largely borne out by recent cross-cultural research. If adults in traditional societies are functioning at concrete operational, or even pre-operational levels, their thinking would be structurally identical to that of children between seven and eleven years old in the West. Cross-cultural researchers no longer look for deficiencies in the mental processes of traditional people to explain these findings; rather they are exploring the sociocultural and educational factors that might be responsible for differences in cognitive growth.

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[30] Heinz Werner, Comparative Psychology of Mental Development (New York: International Universities Press, 1948), p. 299.

Schooling

We have seen that Greenfield found in her study of Wolof children in Senegal that without the experience of schooling intellectual development appears to level off at about the age of nine. Owoc repeated Greenfield's experiments in Nigeria but added an unschooled urban sample, which made possible a 2 by 2 factorial design of urban versus rural and schooling versus no schooling.[31] His subjects ranged in age from six years old to adults. Of the three variables, only schooling and age appeared to be significant. Owoc found that among the unschooled groups "the levelling off of cognitive development began to occur as early as ages 8 to 9 for children living in urban as well as rural settings."[32]

Cole and his associates, carrying out discrimination learning problems with Kpelle children in Liberia, where subjects were required to select a "correct" item in a pair on the basis of one of its physical attributes such as size, color or relationship, found that illiterate subjects treated each subproblem as an isolated unit, in the manner of rote learning. School children learned to solve the problems more quickly over time, reflecting a concept-based learning approach.[33] In the case of verbal logical problems such as syllogisms, illiterate subjects based responses on the particular content of the problem while subjects with school experience responded to the logical relations contained in the problem itself. The authors suggest that Western-style schooling leads both to the acquisition of new intellectual skills and to a change in the situations to which skills are applied. The thinking of traditional peoples, in comparison, is situation bound. They note that one of the universal findings of cross-cultural research has been "that attendance at Western-style schools enormously speeds up the development of problem-solving skills."[34]

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[31] Paul J. Owoc, "On Culture and Conservation Once Again," International Journal of Psychology, 8, No. 4, 1973, pp. 249-254.

[32] Ibid., p. 254.

Why does school apparently make such a great difference in the ability of children to conceptualize? Bruner suggests that learning in school, by its very nature, imposes different cognitive demands on the child. While watching tens of thousands of feet of film on the Bushmen of the Kalahari, Bruner reports he never saw an instance of "teaching" taking place outside the situation where the behavior to be learned was relevant. In simple socieites every man and women knows nearly everything that is needed to participate in the skills, rituals, myths and obligations of the culture. Learning is mostly through modeling. In complex societies, however, the knowledge and skills of the culture far exceed what any individual can know. Increasingly there develops the economical technique of "telling" out of context as opposed to "showing" in context.

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[33] Cole et al., The Cultural Context of Learning and Thinking, pp. 223ff.

[34] Ibid., p. 17.

> . . . school is a sharp departure from indigenous practice. It takes learning, as we have noted, out of the context of immediate action just by dint of putting it into a school. This very extirpation makes learning become an act in itself, freed from the immediate ends of action, preparing the learner for the chain of reckoning remote from payoff that is needed for the formulation of complex ideas. . . . Moreover, in school, one must "follow the lesson" which means one must learn to follow either the abstraction of written speech--abstract in the sense that it is divorced from the concrete situation to which the speech might originally have been related--or the abstraction of language delivered orally but out of the context of an ongoing action. Both of these are highly abstract uses of language.[35]

The Soviet psychologist Vygotsky has pointed out another important contribution of school instruction to the development of thinking.[36] The everyday concepts of children show a lack of conscious awareness of relationships, even though the relationships can be handled correctly in a spontaneous way. For example, if a child is asked to supply the correct ending for the sentence "The man felloff his bicycle because . . ." he will often add a consequence such as "because he broke his arm" rather than a cause. He knows how to use "because" spontaneously, but not deliberately. School instruction plays a decisive role in making the child conscious of specific mental processes, and awareness of one's thoughts is the first step in mastering them. Vygotsky feels that scientific concepts, with their hierarchical system of interrelationships, are the medium in which awareness and mastery first develop. The study of grammar, for example, though it seems to be a subject of little practical use as it does not convey any new skills, is of paramount importance for the mental development of the child because it enables him to become conscious of skills he has acquired unconsciously.

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[35] Bruner, "The Growth of Mind," p. 1009.

[36] L.S. Vygotsky, Thought and Language (New York: M.I.T. Press and John Wiley and Sons, 1962).

Vygotsky points out that the relationship of school instruction to the mental development of the child has been one of the major preoccupations of Soviet psychology. He distinguishes between two kinds of instruction. One is the narrowly specialized training in some particular skill such as is often found in trade schools for adults. It gives practice in the mastery of new habits. The second kind of instruction is the type associated with liberal arts education which he feels opens up large areas of consciousness. Vygotsky compares this type of education to the almost forgotten theory of "formal discipline" which maintained that instruction in certain subjects such as Greek and Latin develops the mental faculties in general, in addition to imparting the specific skills and knowledge of the subject. Vygotsky writes:

> . . . instruction in a given subject influences the development of the higher functions far beyond the confines of that particular subject; the main psychic functions involved in studying various subjects are interdependent--their common bases are consciousness and deliberate mastery--the principle contributions of the school years. It follows from these findings that all the basic school subjects act as formal discipline, each facilitating the learning of the other; the psychological functions stimulated by them develop in one complex process.[37]

Although the degree to which learning in one area of knowledge is transferable to another is a matter which is still being debated, there is undoubtedly truth in Vygotsky's assertion that the formal discipline of school study stretches and stimulates cognitive capacity in general.

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[37] Vygotsky, Thought and Language, p. 102.

Environmental stimulation

While Greenfield found the schooling experience had a marked effect on the performance of Wolof children we have also noted that Price-Williams found no difference between Tiv school children and illiterates in their ability to classify plants and animals according to abstract categories. A number of other studies have also found no correlation between performance on tests of conservation and years of schooling. Mermelstein and Shulman, using a conservation of liquid task, compared Negro children from Prince Edward County, Virginia, where the public schools had been closed for four years, with children from a community which had had regular schooling.[38] They found no significant differences attributable to the effects of non-schooling. A comparison of six and nine year olds from both groups showed the normal pattern of development. Similarly, Goodnow and Benthon found that a group of Chinese boys in Hong Kong with no schooling performed as well as European schoolchildren on tasks for conservation of weight, volume and area, but were markedly poorer than the European schoolchildren on a task of combinatorial reasoning.[39] Piaget himself minimizes the role of training in the acquisition of conservation concepts and stresses instead a wide range of experiences in manipulating real objects in play as well as at school.

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[38] Egon Mermelstein and Lee Shulman, "Lack of Formal Schooling and the Acquisition of Conservation," Child Development, 38, 1967, pp. 39-51.

[39] Jacqueline J. Goodnow and Gloria Benthon, "Piaget's Tasks: The Effects of Schooling and Intelligence," Child Development, 37, No. 3, 1966, pp. 573-582.

Price-Williams, Gordon and Ramirez compared the performance of two groups of Mexican children on conservation tasks of number, liquid, substance, weight and volume.[40] An experimental group consisted of children who had grown up in pottery-making families and a control group was composed of children, matching in age, socioeconomic class and schooling, but whose families were engaged in other occupations. On all five tasks the potters' children conserved more frequently than the other group, but the results were found to be significant only for the conservation of substance, which in this experiment was clay. The findings appear to support the view that experience, particularly manipulation, plays an important role in the attainment of conservation.

DeLemos found that a number of Aboriginal children who had attended school for as much as eight years still failed consistently to conserve throughout a series of tests while at the same time a number of adults and children who had had no schooling whatsoever showed clear conservation. "There does not therefore appear to be a direct relationship between the development of conservation and Western-type schooling."[41] DeLemos suggests that these findings give further support to Piaget's contention that conservation is dependent upon underlying internal processes that are developed through the child's interaction with the physical environment and are not due to any specific training. Contact with a technical and industrialized society may provide the appropriate experience and be a more important factor than schooling in the attainment of concrete operations; DeLemos feels that this would account for the inconsistencies in the school versus non-school findings. Prince Edward County children tested by Mermelstein and Shulman and those in Hong Kong tested by Goodnow and Penthon were living in fairly industrialized and technically sophisticated societies which apparently provided sufficient stimulation without schooling. The school experience, however, became an important variable among the Wolof children tested by Greenfield who were living in a rural, non-technical society. This explanation does not account for the fact that Price-Williams found both schooled and unschooled Tiv children to be capable of conservation or for the fact that Owoc found the urban-rural variable in Nigeria to be insignificant. It is possible, however, that some rural cultures allow their children more interaction with the physical environment than some urban children.

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[40] D. Price-Williams, W. Gordon, and M. Ramirez, "Skill and Conservation: A Study of Pottery-Making Children," Developmental Psychology, 1, No. 6, 1962, p. 769. Reprinted in Berry and Dasen, Culture and Cognition, pp. 351-352.

[41] DeLemos, "The Development of Conservation . . .," p. 266.

Goodnow has sought to explain the conflicting findings regarding the influence of schooling by shifting emphasis from a concept of overall lags in development to one of differential vulnerability among tasks.[42] Conservation of amount, weight, volume and area appear to be fairly sturdy, showing the least degree of change across cultural milieus, whereas conservation of length, time and speed are handled relatively poorly in some cultural settings. Goodnow suggests that the less vulnerable tasks are those for which the child has an action model:

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[42] Jacqueline J. Goodnow, "Problems in Research on Culture and Thought," in D. Elkind and J.H. Flavell (eds.), Studies in Cognitive Development: Essays in Honor of Jean Piaget (New York: Oxford University Press, 1969), pp. 439-462.

> As one Chinese boy explained, a caddy of rice may come in different shaped bags, but it is always a caddy; he has carried them and he knows. Such action backstops to reasoning may be especially important to children who have not had a great deal of schooling.[43]

The more vulnerable tasks are those requiring words, drawings, visual imagery or some other nonmotor representation. In addition to the evidence of her own study, where unschooled Hong Kong children performed as well as schoolchildren on conservation problems but fell down on a task of combinatorial reasoning, Goodnow cites a study by Vernon comparing the performance of English and West Indian eleven year olds.[44] The two groups performed almost identically on problems involving conservation of area, volume and amount, but on two experiments that made use of drawings the performance of the West Indian sample was dramatically inferior. In one of the tests the subject was shown a tall glass of water and a drawing of a dish and asked what would happen to the amount of water if it were poured into such a dish. Although the West Indian children had generally been able to conserve when water was actually poured from one container to another, approximately half of them failed to do so when a drawing was substituted for the real dish and the transformation had to be imagined rather than seen. Goodnow felt the nature of the task was changed from one of physical shuffling to one of mental shuffling. We have also seen evidence in the previous chapter that drawings of objects are not treated in the same way as the objects themselves and that there may be difficulties stemming directly from translating stimuli into pictorial form--difficulties that would be less likely to confuse the schoolboys. Vernon's second experiment involved a drawing of an insect with a clear head and tail shown on top of a circle representing a jar on its side. The subject was asked to draw how the insect would look if it crawled around the rim of the circle to a point on the bottom. Seventy-one percent of the English boys showed the insect with its head pointed correctly as opposed to only twenty-eight percent of the West Indians. Goodnow feels that the cross-cultural findings reveal a consistency in the kinds of tasks that traditional cultural groups have difficulty with:

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[43] Goodnow and Benthon, "Piaget's Tasks . . .," p. 581.

[44] Jacqueline J. Goodnow, "Cultural Variations in Cognitive Skills," in Price-Williams, Cross-Cultural Studies, pp. 254-255.

> . . . they seem to be predominantly tasks where the child has to transform an event in his head, has to shift or shuffle things around by some kind of visualizing or imaging rather than by carrying out an overt series of changes. The spatial or perceptual aspect of these tasks comes as something of a surprise. It used to be thought that "disadvantaged" groups would be most handicapped on verbal or abstractive tasks and that imaging or spatial-type tasks would be the fairest. This seems not to be so, and a division of tasks into "verbal" and "nonverbal" seems not to be the most fruitful that could be made.[45]

The cross-cultural studies of cognition reviewed in this chapter seem to indicate that Piaget's stages of mental development are common to all cultural groups but that the rate of development and the ultimate degree of intellectual attainment are dependent upon particular experiences which may not be available in all cultural environments. Furthermore, we have seen that conservation may be less of a general skill than was previously thought and more influenced by experience with specific types of content. In the case of action based tasks manipulative experiences seem to be important. This would explain the superiority of the potters' children in conserving amount. On the other hand, the school experience, which involves learning out of context, may facilitate the development of representational skills. This would account for the school children's superior performance on the task of combinatorial thinking and in the problems which made use of drawings. Finally it appears that the cognitive abilities required to handle drawings, diagrams, and maps are of the latter type and require the more symbolic visualization processes associated with formal learning, even if the drawings "represent" action based tasks.

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[45] Jacqueline Goodnow, "Cultural Variations in Cognitive Skills," p. 249.

Implications for Education

A provocative thesis by Goody and Watt attributes the distinctive features of Western thought to the advent of alphabetic literacy and the very different cultural demands it created from those that prevail in traditional oral societies.[46] The rise of Greek civilization is the prime historical example of the transition to general literacy and the essential one for any attempt to isolate its cultural consequences. The development of Western thought is usually traced back to the radical innovations of the pre-Socratic philosophers of the sixth century B.C. Goody and Watt see the essence of their intellectual revolution as a change from mythical to logico-empirical modes of thought. Oral traditions are constantly kept in harmony with social needs through a subtle process of adaptation and omission. But once the history, religion and cosmology of a culture is written down, succeeding generations have to wrestle with the patent inconsistencies and try to bring the implied beliefs and attitudes in line with current ones. Thucydides was the first to distinguish between myth and history. It became evident that the past was different from the present and a more conscious, comparative and critical attitude toward the past arose which would not have been possible in a preliterate society. Plato and Aristotle conceived of a system of rules for thinking, rules which were quite distinct from the particular problem being thought about and which they felt offered a more reliable access to the truth than current opinion. Their logical procedure consisted of an analysis of a problem into its constituent elements and a subsequent rational synthesis. The same process of dissection was applied to the elements of experience. Aristotle began the compartmentalization of knowledge into the autonomous cognitive disciplines such as theology, physics, biology, etc., which have become universal in Western culture and remain one of the cardinal differences between literate and nonliterate societies. Furthermore, lacking the possibilities for unconscious adaptation and omission which exist in oral transmission the cultural repertoire began to grow beyond the capability of any one individual to master.

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[46] Goody and Watt, "The Consequences of Literacy."

> *Literate society, merely* by having no system of elimination, no "structural amnesia," prevents the individual from participating fully in the total cultural tradition to anything like the extent possible in nonliterate society.[47]

People involved in education in developing countries are aware that the processes of acculturation and modernization are constantly exposing village people to the logico-empirical modes of thinking and to the wider cultural repertoire of what has become no longer describable as Western civilization but as world civilization. As contacts between cultures increase, the process of absorbing new ideas and practices becomes irreversible. Leonard Doob claims that all ethnic groups must become civilized sooner or later, otherwise they will perish.[48] DeLemos, pondering the implications of the apparent retardation in development among Aboriginal children, writes:

> The results of the study clearly indicate that conservation is developed much later in Aboriginal children than in European, and in some cases appearing not to develop at all. According to Piaget's theory, the failure to achieve conservation would indicate a pre-operational level of thinking, implying an inability to form logical concepts or to apply logical operations to the organization and systematization of concrete data, and affecting the level of logical thinking in all areas.[49]

One of the tasks of development education, whether formal or nonformal, must be to introduce the logico-empirical modes of thought that are required to participate in the culture of the modern world. We would agree with Vernon who writes:

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[47] Goody and Watt, "The Consequences of Literacy," p. 334.

[48] Leonard W. Doob, Becoming More Civilized (New Haven: Yale University Press, 1960).

[49] DeLemos, "The Development of Conservation in Aboriginal Children," pp. 265-266.

> Despite their varying needs and ways of life, all peoples have problems to solve, new situations to meet, and it is likely that they can cope with these more effectively through logical thinking of the same kind of complexity as that built up in the western world.[50]

Enactive, iconic and symbolic modes of learning

Bruner has pointed out that in traditional cultures the modes of learning are either enactive or iconic--the child learns by doing or by modeling. All forms of knowledge as well as attitudes and values are transmitted in the context of day-to-day activity and through face-to-face contact among individuals. Malinowski has even classified language with the active modes of human behavior rather than with the reflective and cognitive ones.[51] In its developed literary and scientific functions, language is an instrument of thought and the communication of thought, but meaning in a primitive language is to a high degree dependent upon the context in which it is used:

> . . . language originally, among primitive peoples was never used as a mere mirror of reflected thought. The manner in which I am using it now, in writing these words, the manner in which the author of a book, or a papyrus or a hewn inscription has to use it, is a very farfetched and derivative function of language. In this, language becomes a condensed piece of reflection, a record of fact or thought. In its primitive uses language functions as a link in concerted human activity, as a piece of human behavior. It is a mode of action and not an instrument of reflection.[52]

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[50] Vernon, Intelligence and Cultural Environment, p. 91.

[51] Bronislaw Malinowski, "The Problem of Meaning in Primitive Languages," in C.K. Ogden and I.A. Richards, The Meaning of Meaning: A Study of the Influence of Language upon Thought and of the Science of Symbolism (New York: Harcourt, Brace and World, Inc., 1923), pp. 296-336.

[52] Ibid., p. 312.

Thus in traditional societies the entire cultural repertoire can be transmitted by enactive and iconic processes. But the successful introduction of new ideas and technologies not to mention new economic and political practices, will require that some members of society develop more flexible and efficient methods for processing information. The range of problems a society would be capable of dealing with would be enormously extended if knowledge could be transmitted through symbolically coded experience.

Bruner calls pedagogy "the psychology of assisted growth."[53] He has identified three kinds of instruction paralleling his three modes of knowing.[54] All are extensions of basic forms of interaction with the environment. Active knowing is a product of one's own experience, "learning by doing." Instruction only enters into the picture when the environment is intentionally pre-arranged by another person. The instructor may select, simplify or order the environment as a way of gently guiding the learner's interactions with it. Iconic knowing comes from observation. It is "learning by seeing." The instructor provides demonstrations and perhaps feedback and the learner models the actions of the instructor. As we have seen, these are the forms of knowing and learning that are common in traditional nonliterate societies. The third kind of knowing is symbolic and includes the use of various culturally mediated symbol systems such as propositional language, mathematics, writing and pictorial forms of communication.

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[53] Bruner, "The Growth of Mind," p. 10012.

[54] Bruner and Olsen, "Learning through Experience and Learning through Media," p. 27.

This is "learning by being told" and the instructor provides facts, descriptions and explanations. Some of the technologies or media which are commonly used in each type of instruction have been identified by Bruner and Olsen and are listed in Table 3.

TABLE 3

INSTRUCTIONAL TECHNOLOGIES USED IN CONNECTION
WITH BRUNER'S THREE MODES OF KNOWING

I. Active knowing or learning by doing

  a. Structured environments
  b. Laboratory experiments
  c. Simulations
  d. Educational toys

II. Iconic knowing or learning by seeing

  a. Films and animation
  b. Demonstrations
  c. Modeling

III. Symbolic knowing or learning by being told

  a. Verbal instruction
  b. Print
  c. Drawings
  d. Diagrams
  e. Graphs
  f. Maps
  g. Models
  h. Numbers

The use of a symbolic medium for instructional purposes is contingent upon the learner's being literate in that medium. A further limitation of symbolically coded instruction is that no really new information can be conveyed. Symbols are representations of a reality that is already known. As Bruner and Olsen point out in the case of verbal instruction:

> If the information intended by the listener falls outside the speaker's "competence," the listener will interpret that sentence in terms of the knowledge he already possesses. It follows that instruction through language is limited to rearranging, ordering and differentiating knowledge or information that the listener already has available from other sources such as modeling or through his own direct experience.[55]

The same limitations apply to all symbolically coded information, including pictorial communication.

But more important than the kinds of knowledge that can be conveyed by the three modes of instruction are the skills involved in extracting and utilizing that knowledge. Bruner and Olsen feel that "in regard to the skills they develop, symbolically coded information differs radically from contingent experience and from modeling."[56] Educators, they feel, have traditionally been concerned with knowledge per se and have tended to take for granted the skills that are needed in order to acquire and use knowledge. For example, if we examine a rock by turning it over in our hand, we are aware that we are acquiring knowledge about the rock, but the skilled manipulation that made the knowledge possible is transparent to us. The skills required to interpret drawings, diagrams and maps are equally transparent.

According to Piaget, symbolic activity is one of the hallmarks of pre-operational thinking. Play and language, for example, are forms of symbolic behavior. Many of the child's first symbols are egocentric, as when a stick represents an airplane or a wooden block a car.

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[55] Bruner and Olsen, "Learning through Experience and Learning through Media," p. 33.

[56] Ibid., p. 36.

But other symbols, such as language, gestures and pictures, are autonomous and must be learned. Such symbols are part of the total cultural environment to which the growing child responds. The meaning of arbitrary symbols is imposed by society and because of this, they have the capacity to act as means of communication. In Western society the skills required to interpret pictures are learned through a process of constant interaction with pictorial material. We come to participate in the conventions of graphic representation unconsciously, just as we are unaware of our growing mastery of linguistic signs. The fact that no overt "teaching" takes place masks the fact that important skills are being developed. Also, because we can understand the pictures of other countries but cannot read their languages we are led to the naive assumption that understanding pictures is a spontaneous and self-evident matter. The symbols of pictorial communication, however, like mathematics, have become international, while each culture continues to socialize its members into its own particular language. It is only when we introduce pictures to a culture where there has been no opportunity to acquire the skills necessary to interpret them that we discover their complex, symbolic nature. Picture illiteracy is just as real as alphabetic illiteracy.

Strategies for nonformal education

We have seen from the cross-cultural research that village life often fails to provide the intellectual demands that will stimulate some of the higher cognitive processes identified by Piaget. Many illiterate adults apparently do not reach the concrete operational stage of thinking, not to mention the hypothetico-deductive logic of the formal operational period. We have also seen that where environmental stimulation is inadequate, schooling can have a powerful influence on cognitive growth. Bruner suggests that by removing learning from the context of action, schooling imposes radically new intellectual demands upon the village child. The propositional language of school is more abstract and symbolical than the action-oriented language of daily life. Vygotsky sees awareness and mastery of concepts as the most important contributions of the school experience. Consciousness and deliberate control, he feels, are the first steps in using a concept purposefully. This process begins with scientific concepts which are taught in an organized and interrelated manner, and it is Vygotsky's contention that this awareness spreads eventually to the spontaneous concepts of everyday life until it permeates all aspects of thinking. In this way every school subject acts as a kind of "formal discipline," opening doors to whole new areas of cognitive growth.

Vygotsky distinguished between two types of instruction--the narrowly specialized training that is characteristic of vocational schools and the kind found in liberal arts education which develops the mental faculties in general. The instructional methods that are used in vocational training and to a large extent in nonformal education are the kinds that Bruner has identified as enactive and iconic. Demonstrations, modeling and "hands on" experience are successful in rural development work because they utilize traditional methods of instruction. However, the vital element of the school experience, which is the intellectual stimulation that will stretch the thinking capabilities of the learner, is absent. This is perhaps the major weakness of present nonformal educational approaches. Meaningful rural development will require new intellectual as well as new manual and technological skills. Some manner of "formal discipline" needs to be incorporated into nonformal education. Certainly literacy training will provide stimulation of this kind. It is also possible that learning the symbolic language of pictures can have a similar effect. Curriculum modules created with specific rural development objectives in mind, which include both practical and formal elements, could be beneficial for both in-school and out-of-school programs.

Cross-cultural research has shown that formal schooling by itself is not sufficient to enable village children to understand spatial information in pictures. Because the skills required to interpret pictorial material are transparent they have never been a subject of direct instruction. We have seen that in the West pictorial skills are learned inductively through a process of constant exposure and interaction. It would seem beneficial, therefore, to begin introducing pictorial material in both formal and nonformal programs even though it is realized that very little content can, as yet, be communicated in this manner. Curriculum modules in agriculture, health, nutrition, environmental sanitation, family planning and a host of other development related topics could gradually introduce pictorial elements in a carefully graded sequence. The first pictures would consist of representations of familiar objects. It is evident that unacculturated villagers interpret pictorial space topologically rather than projectively. It is possible, then, that topological concepts such as order, proximity, separation and enclosure would be among the first spatial concepts that village people could master in pictorial form. Part II of this dissertation will investigate a number of aspects of picture recognition and pictorial space comprehension in order to discover if there is any natural sequence of conceptual development in pictorial understanding. Teaching techniques, such as the portable frame window used by Dawson and by Duncan, Gourlay and Hudson to introduce three-dimensional cues should also be investigated.

We have seen from the research on picture perception that there are several levels of pictorial ability, the most basic of which is the recognition of familiar objects. By themselves, pictures at this level of communication can hardly be called instructional, but it is a good point of departure. Fuglesang's experience in Africa has led him to the conviction that visual aids can be powerful tools in development work, but that they cannot stand on their own.

> Basically such visual aids are teaching aids. They do not speak sufficiently well for themselves but must be explained and literally be used as an aid during the teaching session. Used properly they add greatly to the quality of the teaching and to the interest of the students.[57]

Pictures can be useful, then, so long as they are accompanied by a verbal explanation. Thus we would expect a flip chart or a slide show to be a better way of introducing pictorial communication to a village audience than, say, a poster. But more importantly, the very fact of using a flip chart, accompanied by a verbal explanation, would begin the process of developing the skills needed for symbolic learning. The same careful research that has gone into curriculum planning for formal education should be applied to developing curricula for nonformal education in villages. Both the development messages and the "coding-decoding" process are subjects that require systematic investigation. Practice in the use of pictures along with propositional language and similar technologies will develop "literacy skills" in the various forms of symbolic media. These can be carefully incorporated in the appropriate sequences into the curriculum modules.

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[57] Fuglesang, Applied Communication, pp. 106-107.

PART II

CHAPTER IV

PROBLEMS OF PICTURE RECOGNITION

In Part I we discussed two current theories of picture perception, one emphasizing active selection and the other passive reception. According to the "constructive" view advanced by Gregory, pictures are such artificial and ambiguous stimuli that it is a wonder that we make anything of them at all, whereas according to the "registration" view proposed by Kennedy, picture recognition is to a large extent a gift allowed us by the environment. The evidence of cross-cultural research offers support for both positions. Common objects such as a human figure or a familiar animal seem to be recognized without prior pictorial exposure, whereas the perception of depth in pictures appears to depend upon a fairly high level of sophistication. It is evident that understanding pictures is not an all-or-nothing affair and that various levels of skills are involved. In Part II we shall describe a series of experiments carried out in Nepal which investigate problems of picture recognition, spatial abilities, and the comprehension of pictorial space. Our primary interest will be to assess the ability of village adults to interpret representational material, and to answer questions about qualitative differences in pictorial skills. If any generalizations can be made about the kinds of pictorial abilities that are spontaneous, or at least are acquired with limited experience, and those that require learning or depend on other cognitive skills, it will be possible to establish principles for the sequential design of representational materials which will be appropriate for rural development. In Chapter IV we will consider problems of picture recognition, comparing the effectiveness of photographs and line drawings, and examining the use of pictures as "blueprints" for simple construction tasks. In Chapter V we will study a number of spatial abilities using Piagetian methods and relate the development of spatial understanding to problems of picture space. Finally, in Chapter VI the findings will be reviewed and their applications will be discussed.

Background of the Study

Nepal is a Hindu kingdom lying in the lap of the Himalayan Mountains with a population of about thirteen million. It was never colonized and until the middle of this century it was virtually cut off from outside influences. When Nepal opened its doors to the modern world in 1950, less than one percent of its population had attended school and only two percent was literate. According to United Nations statistics, Nepal is one of the five least developed countries in the world, and with an annual per capita income of less than $100 it is among the poorest. The present leadership of Nepal is committed to developing the nation's resources and modernizing its economy. This process has been greatly hindered, however, by the country's formidable terrain and the fact that when the process of modernization began, Nepal lacked the means of communication and the educated population that were required for development--assets which were enjoyed by most of the countries emerging from colonialism. This has meant that for the past three decades efforts and resources have been poured primarily into the development of basic infrastructure while the country's gross national product has hardly kept pace with population growth. Nepal is a classic example of a country where nonformal approaches to education, from both the point of view of cost and of need, are of great relevance.

The people of Nepal are subsistence level farmers with individual landholdings averaging approximately one acre per family--among the smallest in the world. Although the country is officially a Hindu state, there is a large Buddhist population and followers of the two religions mingle freely, frequenting each other's temples, and even observing one another's holy days. The original people of Nepal were of the Mongolian race, but during the period of the Moslem invasion of India a large migration of Aryans spread into the southern and middle regions, so that today Nepal is a mixture of a great many ethnic and linguistic groups. The national language is Nepali. It is spoken by educated people throughout the country and even in regions where it is not the dominant language, it is understood by a large portion of the population. Most recent statistics estimate that approximately 85% of the people of Nepal are illiterate.

Preliminary experimentation was carried out by the author in a village in the Hill Region of central Nepal. The purpose of this experimentation was to explore general levels of performance and areas of difficulty in picture perception and logical thinking. A series of seventeen tests was carried out, involving problems of conservation, classification, spatial abilities and pictorial skills. Approximately thirty subjects, men and women, ranging in age from twelve to over fifty participated. The results will not be reported as the purpose of the preliminary testing was to establish guidelines for the development of the experiments which follow. A number of interesting questions were raised during this period of preliminary investigation and subsequent tests were designed with these questions in mind.

Subjects

Experiments were carried out during the summer and early fall of 1978 towards the end of the monsoon season. Three samples were tested, the largest being a village sample. For purposes of comparison two other groups were added to the experiment. One was comprised of workers in a furniture factory in the capital city of Kathmandu and the other was a group of students in their second year at Tribhuvan University's Institute of Engineering, also in Kathmandu.

The village sample

Because the monsoon rains make travel in the Hill region exceedingly difficult during the summer, testing of village subjects was carried out in the Terai, the lowlying southern plain which borders on India. Travel in the Terai is not nearly so difficult as in other parts of the country, so that all of these village subjects had had opportunities to visit the regional market centers. Many had ridden on busses, been exposed to billboards and magazines, and generally their level of acculturation would have to be rated higher than the country-wide average. Forty-two subjects living in seven separate villages plus three village women who had recently migrated to the city comprised the village sample.

Age range. Ages ranged from fifteen to seventy, with an average of 32.9, so that all subjects, from a Piagetian standpoint, would be considered capable of fully mature intelligence. The following table breaks down the ages by group.

TABLE 4

AGE RANGE OF THE VILLAGE SAMPLE

Age	Number
15-19	4
20-29	19
30-39	11
Over 40	11

Although the accuracy of ages in Nepal is generally subject to question, for the purposes of these experiments accuracy is not important.

Sex. Of the forty-five village subjects, six were women. In addition to these, two illiterate women who had grown up in the city were also tested, bringing the total number of women to eight. The performances of the two urban women will be reported in the discussion of the tests, but are not included in the comparison of subgroups within the sample. The number of women participating in the experiments was too few to make intersex comparisons useful.

Ethnic background. Of the seven villages where testing was carried out, five were in a region where the most numerous ethnic group was Tharus, the traditional inhabitants of the Terai region. They are a quiet, hospitable and peaceful people, but have traditionally been exploited by more aggressive and better educated ethnic groups. Of the forty-five subjects in the village sample, twenty-four were Tharus. The next most numerous group was Brahmins, members of the Hindu priest caste. They are among the Aryan groups that migrated to Nepal during the twelfth century. Village Brahmins in the Terai are more conservative than those in the hills. Married women in well-to-do families generally do not set foot outside the four walls of their houses, a luxury which poorer families can ill afford. Brahmins who have recently migrated from the Hill region, however, do not observe many of these orthodox customs. Eight Brahmins were included in the sample, two of them from the Hills. The only other Hill person was a woman who belonged to a Buddhist tribal group, the Magars. The remaining subjects belonged to various Hindu occupational castes such as Yadavs (milkmen), Kalwars (traders), Thakurs (ironworkers), Kumhales (potters) or to castes that have traditionally worked the land for others such as Bantars and Bhujels. Table 5 gives a breakdown of the village sample by caste or ethnic group.

TABLE 5

ETHNIC BACKGROUND OF THE VILLAGE SAMPLE

Caste or Ethnic Group	Number
Tharu	24
Brahmin	8
Yadav	4
Kalwar	2
Bhujel	2
Bantar	2
Thakur	1
Kumhale	1
Magar	1

The two urban women were Newar and Tamang respectively, both Buddhist ethnic groups indigenous to Nepal.

Occupation. The majority of subjects were engaged in farming, and in spite of the traditional caste occupations of many of them, thirty-three cited farming as their primary activity. The six women were engaged in household work but during planting and harvest seasons they too would be required to work in the fields. The sample also included two carpenters, a bricklayer, a paraprofessional health worker, a supervisor in a nearby sugar mill, and a ninth grade student, the youngest member of the sample.

Schooling. Nineteen of the village subjects had attended school, including three of the six women, one of the carpenters, the supervisor, the paraprofessional health worker and, of course, the ninth grader. Table 6 shows the level of schooling completed by these nineteen subjects.

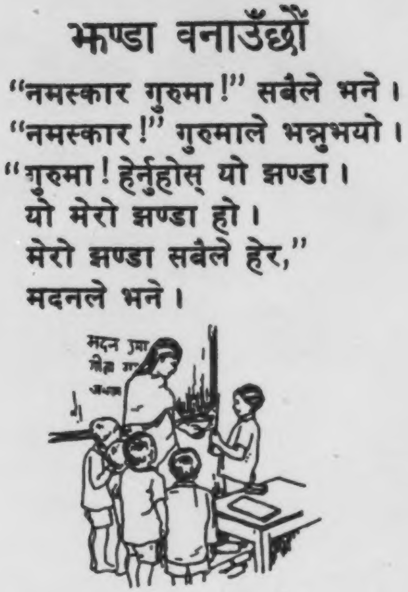
TABLE 6

LEVEL OF SCHOOLING ATTAINED BY MEMBERS OF THE VILLAGE SAMPLE

	Number
Primary School	
Grade III	2 farmers
Grade IV	3 farmers
Grade V	3 women 1 carpenter
Secondary School	
Grade VII	2 farmers 1 supervisor
Grade VIII	3 farmers
Grade IX	1 student
Grade X	2 farmers
Grade X plus 2 years of special training	1 health worker

The remaining twenty-six village subjects, including three women, the second carpenter and the bricklayer had had no formal education.

Literacy. Subjects were also tested for literacy and divided into three categories: literate, partially literate, or illiterate. They were asked if they could read and if they said they could or knew a little, they were given a page from a first grade primer and asked to read it (see Figure 19). If the passage was read fairly easily, the respondent was judged as literate. If it was read with difficulty or if only a few words could be made out the respondent was



झण्डा वनाउँछौं

"नमस्कार गुरुमा!" सबैले भने।
"नमस्कार!" गुरुमाले भन्नुभयो।
"गुरुमा! हेर्नुहोस् यो झण्डा।
यो मेरो झण्डा हो।
मेरो झण्डा सबैले हेर,"
मदनले भने।

Translation:

LET'S MAKE A FLAG

"Good morning, Teacher," everyone said.
"Good morning," the teacher replied.
"Teacher! Please look at this flag.
This is my flag.
Everyone, look at my flag,"
Madan said.

FIGURE 19

Page from a first grade primer used for test of literacy judged to be partially literate. The remainder were categorized as illiterate. All of the subjects who had attended secondary school were found to be literate, but five of the nine who had attended primary school were judged to be only partially literate. While investigating the reading ability of schoolchildren during the preliminary experimentation, the author found that the rote learning approach did not provide an adequate foundation for many of the children. If asked to read a page they could recite it with ease, but if a single word were isolated they could not tell what it was without going back to the beginning and working their way through the memorized text until they came to it. Furthermore, the lack of reading material in the environment had undoubtedly caused the reading skills of many of these subjects to weaken over the years. All of the partially literate school-going subjects were in their 20's and 30's and had attended primary school many years before. Of the unschooled subjects, one was found to be literate and ten partially literate. The remaining fifteen were illiterate. The educational status of the sample is summarized in Table 7.

TABLE 7

EDUCATIONAL STATUS OF THE VILLAGE SAMPLE

	No School	Primary School	Secondary School
Illiterate	15	0	0
Partially Literate	10	5	0
Literate	1	4	10

The two urban women were both unschooled and illiterate and engaged in household work.

The furniture factory sample

During the testing of village subjects it was noted that the performances of the two carpenters and the bricklayer were consistently above average. It was felt that the nature of their work might contribute to a better understanding of spatial concepts. In order to compare the performance of the village subjects with an urban sample engaged in a fairly skilled manual occupation, a group of ten workers in a furniture factory was tested. Work at the factory is done in a fairly traditional manner, with employees squatting on the ground, normally holding a piece of wood between their feet as they work on it. The factory has a power saw and a limited number of electrical tools, but most of the work is done by hand. The factory produces household and office furniture such as chairs, tables, desks, cupboards and beds Half-finished pieces are piled about the courtyard in a hodge-podge manner.

Ten men were tested at the factory including the manager. They ranged in age from twenty-two to fifty-nine, with an average of 40.3. All were Newars, an indigenous ethnic group of the Kathmandu Valley, and most of them belonged to the traditional Newar occupational caste of woodworkers (Sthapits). In addition to the manager, five of the subjects were carpenters, two were polishers, one an upholsterer and one a carrier. Three of the ten had attended primary school and three secondary school. Four had had no formal education. Five of the subjects were categorized as literate, four as partially literate and one as illiterate.

The student sample

It was noted during testing of the villagers that a number of subjects with secondary school education performed poorly on some of the tasks. It was felt that a comparison group of college level students should be tested, both in order to validate the experiments themselves and to determine the effects of specific training relevant to the demands made by the tests. Therefore, students at the Institute of Engineering in Kathmandu were selected.

Ten male students ranging in age from seventeen to twenty-four comprised the sample. Their average age was 19.7. All of the students were of village origin, having been recruited from their districts for a two year training course with the intention that they would return to their villages and serve in the field. All of them had completed secondary school. Four of the students were Brahmins, two Newars, two were Chhetris, members of the traditional warrior caste, and two were from ethnic tribes of Tibetan origin, Sherpa and Thakali. Seven of the students were engaged in a civil engineering course to prepare them for tasks such as bridgebuilding, road construction, and water supply projects. Two students were specializing in architectural drafting, and one in electrical engineering. Seven were in their fourth and final semester, two in their third and one in his second. Among other things their course of study included a number of skills directly relevant to interpreting pictures and pictorial space, such as:

free hand sketching, basic geometrical drawing, orthographic, isometric and oblique projections, plans, elevations and sections of simple buildings. Although these skills were only one aspect of a two year course of study, it was felt that it would be worth investigating the effects of specific training of this kind.

Method

Based on questions raised during the preliminary investigation a series of twenty experiments was developed and the materials prepared. Only pictorial cues stemming directly from the ecology of light were utilized--cues such as contour, object size, superimposition, perspective, intensity of pigmentation, shading, texture and so forth. We saw in the literature reviewed in Chapter II that arbitrary conventions such as lines of motion and even partial abstractions such as horizon lines, the contours of hills and the edges of roads are not readily understood. The purpose of these experiments was to determine how well cues that derive essentially from everyday experience, and not from learning, can be applied to the interpretation of representational material. Therefore pictures consisted primarily of photographs and line drawings based on photographs. Models, blocks and other concrete objects were also utilized in a number of the experiments. All testing was carried out in Nepali by the author who had sufficient proficiency in the language to ask the fairly simple questions involved, as well as whatever follow up questions were required to clarify uncertain responses. Before taking the experiments to the field, however, all questions were written out in consultation with a competent Nepali translator and a wide range of possible responses was discussed. As it turned out, the author was also able to have a bilingual assistant present during most of the testing. In the few cases where respondents did not speak Nepali a local interpreter was used.

Pre-tests

Pre-testing was carried out in urban areas with illiterate or partially literate women--two of urban background and three who had recently come to the city from their villages. The pre-tests took approximately two hours per subject, so several of the more complicated items were eliminated, reducing the number to fifteen. The entire series could thus be completed in an hour to an hour and a half. In actual practice, however, it was felt that interest and attention could best be maintained if the testing session lasted no more than an hour. Therefore subjects who tended to work slowly were not given every test in the series. In cases where the subject's ability seemed high, some of the simpler items were eliminated. In a few cases where subjects worked extremely slowly and had great difficulty, only the first half or the first few items in a particular experiment were given. During testing, one of the identification experiments proved to be fairly easy and representative of another identification test. For this reason it was used only occasionally. Therefore only fourteen tests were used consistently throughout the experiment of which each villager completed, on the average, twelve. In the cases of the factory and student samples only eight of the more difficult tests were used and an additional ninth one was given to the students--one of those which had been eliminated from the battery given to the villagers.

Selection of subjects

The author was fortunate to have personal friends in the areas of the study who were able to arrange for the selection of subjects. This rather opportunistic approach resulted in a haphazard selection of villagers, but it was felt that any cross-section was likely to be fairly representative. In each village the purpose of the study--to find out how much village people understood from pictures--was explained and the contact person was asked to find a representative group of unschooled adults for interviews. Usually a number of those who had been to school would become interested and ask if they could look at the pictures and answer the questions, too. Unlike the Hills, it was exceptionally difficult to find Terai women who were willing to participate in the experiments. Only three Tharu women agreed to take the tests, whereas in the preliminary experimentation in the Hills, more than 40% of the subjects had been women. The remaining three women in the village sample were of Hill origin. The village sample should not be considered representative of Nepali people in general, both due to the non-random method of selecting subjects and to the fact that more than half of the village participants were Tharus, whose culture and history are in many ways unique among the ethnic groups in that country.

Test conditions

Subjects were tested in individual interviews lasting approximately one hour. The order of tests is shown in the sample questionnaire in the Appendix. Testing in the eastern Terai villages took place during the time of year when the jute crop is being harvested, so that villagers were generally available for questioning around their lunch time, from ten to twelve, and in the afternoon. In all cases a quiet place inside a building was found for the interviews, but because of the informal nature of the testing conditions, it was practically impossible to keep a number of curious onlookers from being present or peering in the windows. Onlookers, however, were asked to remain silent and not give their opinions on the test questions. In a few cases, however, they found it impossible to suppress groans or sighs. Where respondents corrected erroneous answers on the basis of such external reinforcement, the change was noted, but their first response was scored. Onlookers were not subsequently selected as subjects themselves. It had been noted during the preliminary experimentation that after two or more days of interviewing word would circulate about the nature of the tests. Several respondents asked the author questions such as "Aren't you going to ask me the one about the pennies?" Some rather curious answers emerged from these anticipations of the test items which had been gleaned from conversations with those who had previously taken the tests. In order to minimize this unavoidable situation, the author employed the strategy of spending no more than two or three days in any one village. Table 8 lists the villages where the study was carried out and the number of subjects in each location.

TABLE 8

NUMBER OF RESPONDENTS IN EACH VILLAGE OF THE STUDY

Location	Number
Morang District	
Sisawani	10
Sukchar	5
Duhabi	5
Sunsari District	
Khanar	7
Madheli	4
Parsa District	
Apauni	2
Bahuari	9

In addition, two village subjects from the Hill region were tested in Kathmandu and one in Biratnagar.

Identifying Depicted Objects

The first three experiments deal with questions of identification. In Chapter II we mentioned the incident reported by Herskovits of a Bush Negro woman who was unable to identify a black and white photograph of her own son. On the other hand, Hochberg and Brooks found a nineteen month old child able to identify pictures of common objects without prior exposure to pictorial material. Our first experiment utilizes a series of photographs to investigate the ability of village subjects to identify pictured objects. Deregowski found that illiterate Zambian subjects could match photographs to models of animals if the animals were familiar. In our second experiment we compare the performance of village subjects in matching photographs, line drawings and cartoon figures to models of animals. Also in Chapter II we noted D'Andrade's observation that the reason Nigerian children performed poorly with Kohs Blocks might be due to their having few opportunities to use pictures as "blueprints" for action. Our third experiment investigates the ability to use pictures for simple block constructions. Here the problem of identification involves different configurations of blocks. Of the first group of experiments this was the only one given to all three samples.

Experiment 1: identifying photographs

Materials and procedure

Fifteen black and white photographs of familiar objects or activities were presented one at a time. The subject was asked to identify what he saw. In order to offer a variety of problems of interpretations a number of the photographs incorporated unusual angles or points of view.

Subjects

All of the village subjects were asked to complete this experiment except for the student and the health worker. Six protocols were eliminated, five because of poor eyesight and one which was incomplete. Thirty-seven villagers and the two urban women participated in this experiment.

Results

The pictures will be discussed not in the order which they were presented, which can be found in the Appendix, but in order of difficulty, beginning with those which were easiest to understand.

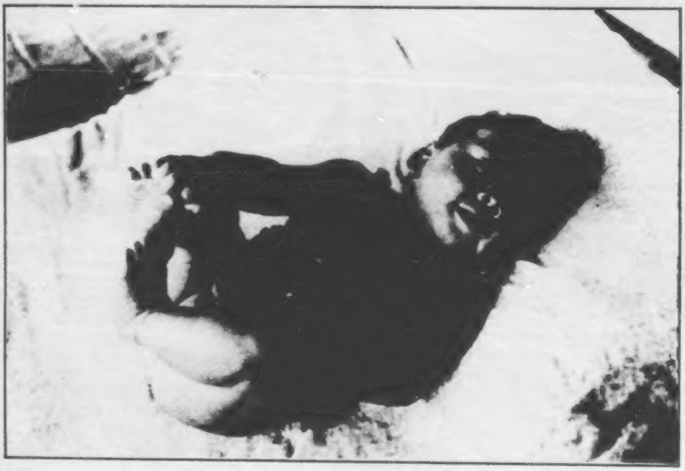


FIGURE 20

Picture 1: baby

Picture 1: baby (Figure 20). This photograph was identified correctly by all respondents. Seven subjects turned it this way and that before answering, no doubt because of the unusual orientation of the figure.

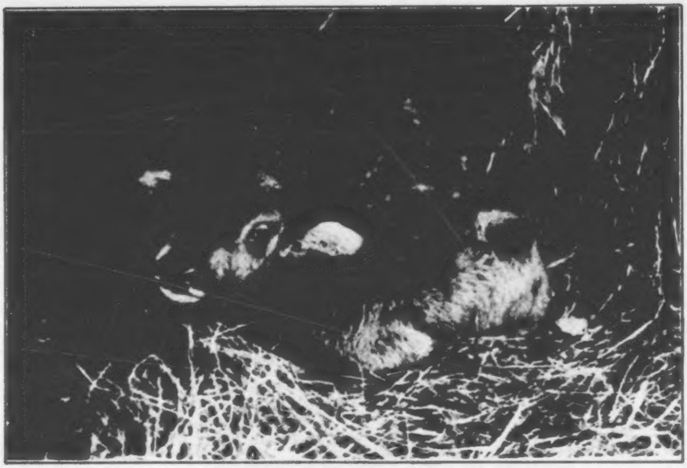


FIGURE 21

Picture 2: buffalo calf

Picture 2: buffalo calf (Figure 21). This picture was identified by all but one, who called it a tiger. This respondent was the poorest in the sample, however, missing eleven identifications out of fifteen. Even so, his erroneous interpretation was not entirely arbitrary as it fell within the class of animals. The creases around the animal's neck could give the impression of being stripes. Acceptable responses included buffalo calf or baby cow. Respondents seemed to have no difficulty separating the object from a fairly confusing background.

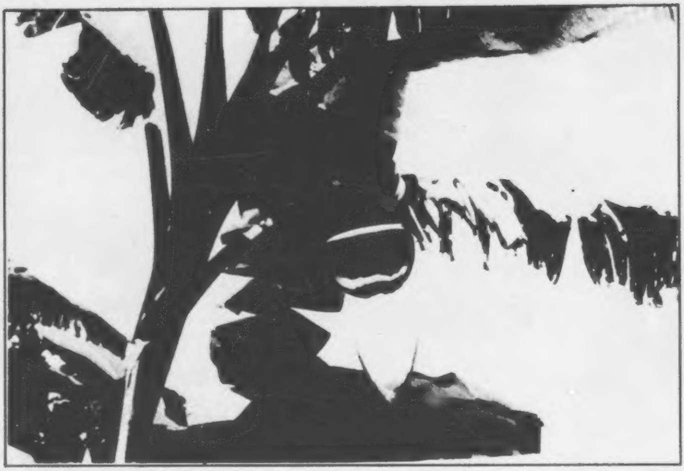


FIGURE 22

Picture 3: bananas

Picture 3: bananas (Figure 22). This picture was identified by all but one--the same respondent who missed the previous picture. He called this one a flower, again the right class if not the right species. The high rate of correct identifications on this picture was somewhat surprising considering the rather abstract patterns of light and shadow.

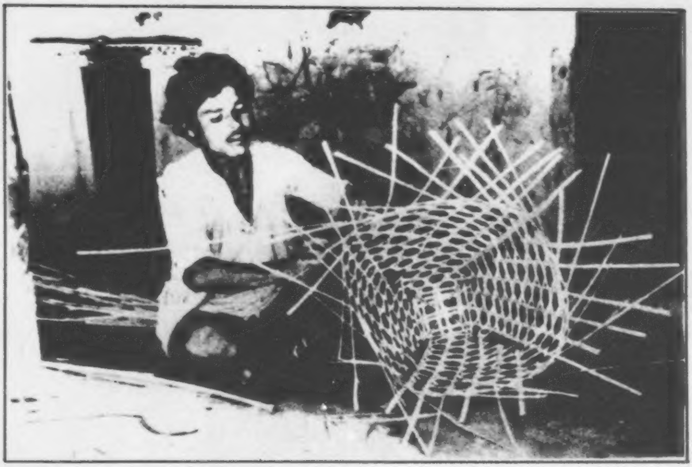


FIGURE 23

Picture 4: making a basket

Picture 4: making a basket (Figure 23). All respondents identified the man. The basket was missed twice. One respondent said the man was at a spinning wheel, another that he was making a plastic bag.

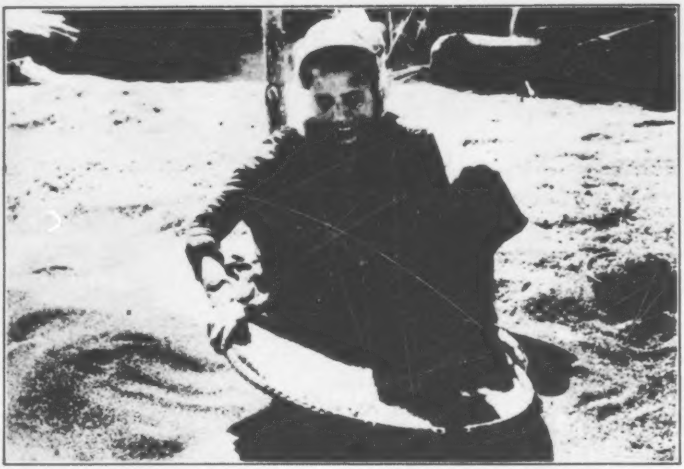


FIGURE 24

Picture 5: woman sifting

Picture 5: woman sifting (Figure 24). All identified the person but two subjects failed to recognize the sifting basket. In addition, one of the Tharu respondents called it a plate, but this appeared to be a language problem, as he understood the action.

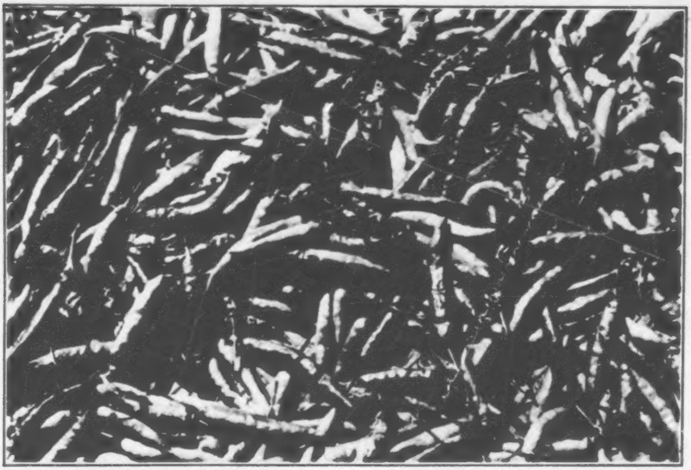


FIGURE 25

Picture 6: peppers

Picture 6: peppers (Figure 25). Peppers are typically spread out on mats and dried in the sun. Two respondents failed to identify this picture. One called it corn and the other did not know what it was. Seven respondents hesitated or turned the picture about before identifying it correctly.

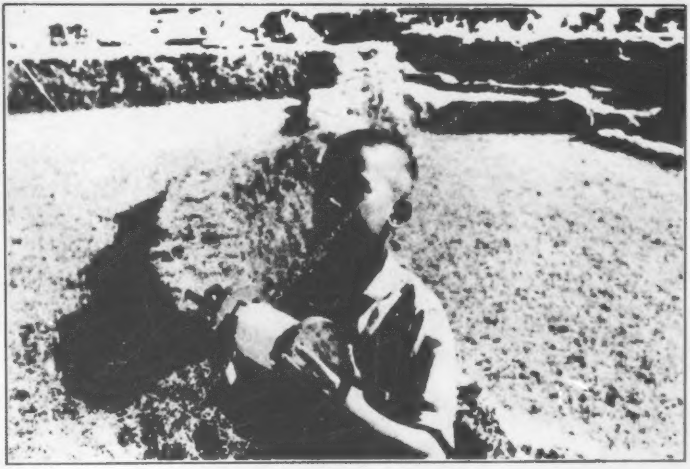


FIGURE 26

Picture 7: flying a kite

Picture 7: flying a kite (Figure 26). Three respondents misinterpreted the action. One said the boy was smoking; another said he was fetching water; the third could not identify the spool. Failure to identify the spool appeared to be the cause of misinterpreting the action in all three cases.

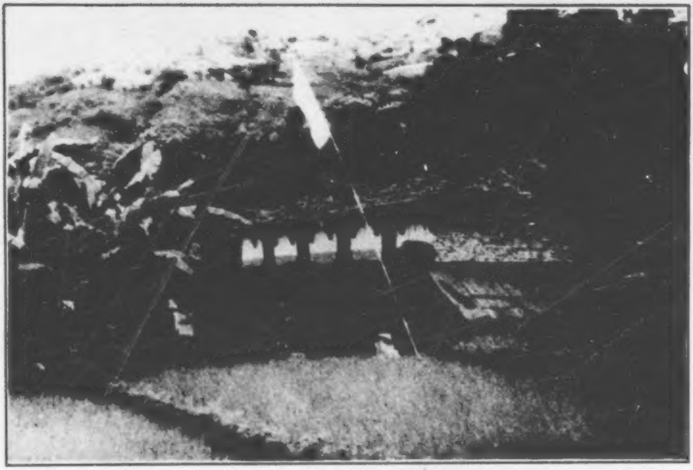


FIGURE 27

Picture 8: house

Picture 8: house (Figure 27). Buddhist families traditionally put prayer flags in front of their houses. Subjects were asked to identify both the house and the flag. Two respondents called the house a temple, which was scored as incorrect and a third said he did not understand the picture. Another subject called the house a school, which was accepted as a plausible response. The picture was taken in the Hills, so the construction of the house is unlike those typically found in the Terai. Nevertheless, all but three of the village subjects correctly identified both the house and the flag and over half mentioned the banana tree on the left. Fourteen subjects were asked if they could tell what religion the people who lived in the house followed. The only two who correctly identified the occupants as Buddhists were the two urban women, both Buddhists themselves. None of the Hindu respondents were able to give this interpretation. Villagers generally do not seem to be aware of the practices of other ethnic groups.

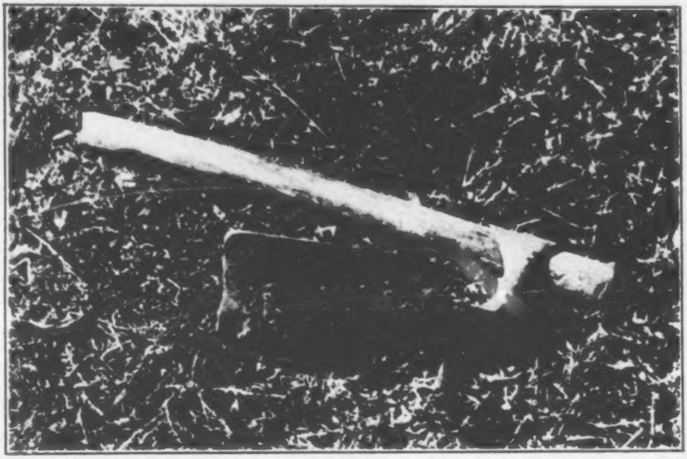


FIGURE 28

Picture 9: hoe

Picture 9: hoe (Figure 28). This picture was misidentified four times. Two respondents called it a chicken; one said it was a pen; the fourth could not say what it was. Six respondents hesitated or turned the picture this way and that before giving their answers. The odd angle and the confusing background did not appear to cause the others difficulty.

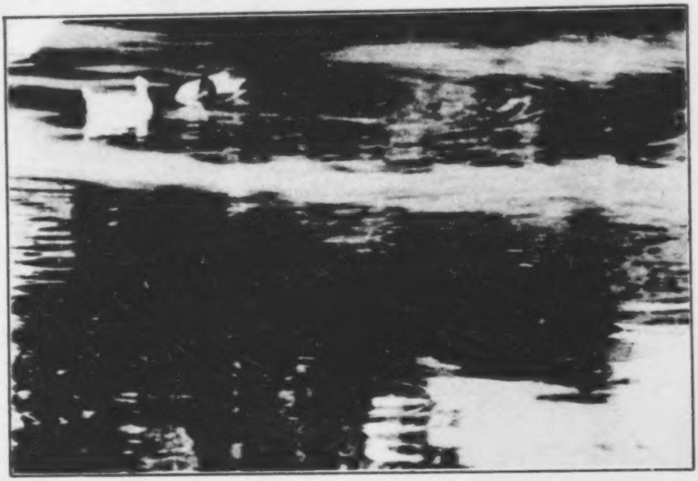


FIGURE 29

Picture 10: water buffalo

Picture 10: water buffalo (Figure 29). Respondents were asked to identify the buffalo and the water. Most of them were also asked to identify the ducks in the background. Although all of the subjects identified the buffalo, five protocols were scored as incorrect. One said the ducks were a man and four could not identify the water. Identification of the water was elicited by questions such as "Where is the buffalo standing?" or "Why can't you see the buffalo's legs?" Two replied that the buffalo was in the jungle, one said it was in the mud and a fourth merely said it was sitting. The patterns that depict the water are fairly abstract in this picture but the additional cues of the ducks, not to mention the fact that water buffalos love to loll about in ponds or streams, certainly must have aided in its identification.

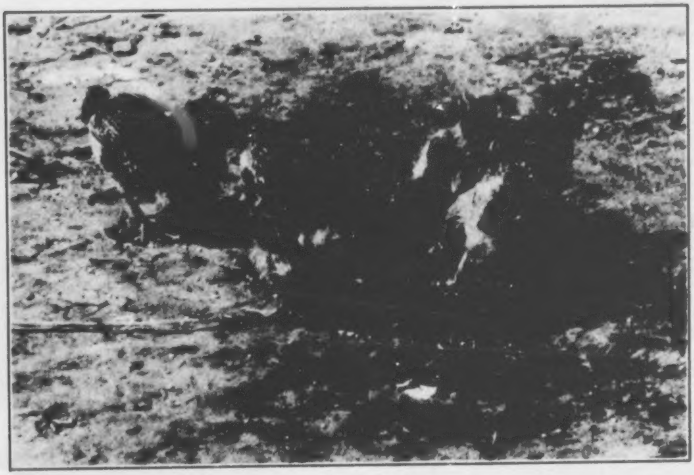


FIGURE 30

Picture 11: baby chicks

Picture 11: baby chicks (Figure 30). Acceptable responses included baby chicks, baby ducks and birds. There were seven protocols that were scored as incorrect: one merely called them animals; one said they were ducks, but in the water; one said they were monkeys, and two did not know. The other two erroneous answers were quite far from the mark. One said it was a boat on a river and the other a hermit who lives in the forest. Of the thirty-two who correctly identified the picture, eight hesitated or turned the picture about before giving their answer. Respondents were also asked how many chicks there were. Here performance was dramatically inferior. Only six respondents gave the correct answer--six chicks. Another two changed erroneous responses when they were asked to point them out. Therefore eight protocols were given credit for correctly counting the number of birds. The remaining twenty-three subjects gave the responses shown in Table 9. All of them were asked to point out the birds they saw.

TABLE 9

ERRONEOUS COUNTS OF THE NUMBER OF CHICKS IN FIGURE 30

5 chicks	8 protocols
4 chicks	12 protocols
3 chicks	1 protocol
2 chicks	1 protocol
Can't say	1 protocol

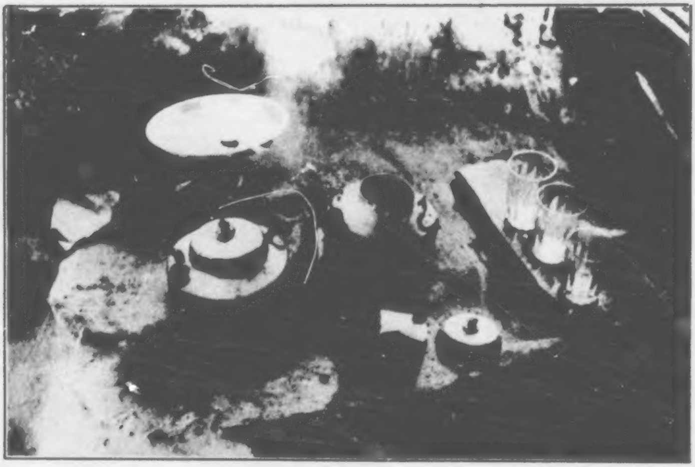


FIGURE 31

Picture 12: tea

Picture 12: tea (Figure 31). These are some of the typical utensils used for making tea shown spread out on a mud stove. Respondents were asked to identify a number of the important items in the picture such as the glasses, the kettles, the packet of dust tea and the lid setting by itself. Ten subjects failed to identify one or more of these objects in spite of their context. The packet of dust tea was the most difficult, being missed eight times. The lid was missed three times. One respondent said the kettles were "like eyes." On the other hand,a number of respondents identified the spoon and plate in the background and the partially shown tongs leaning against the stove in front of the lid.

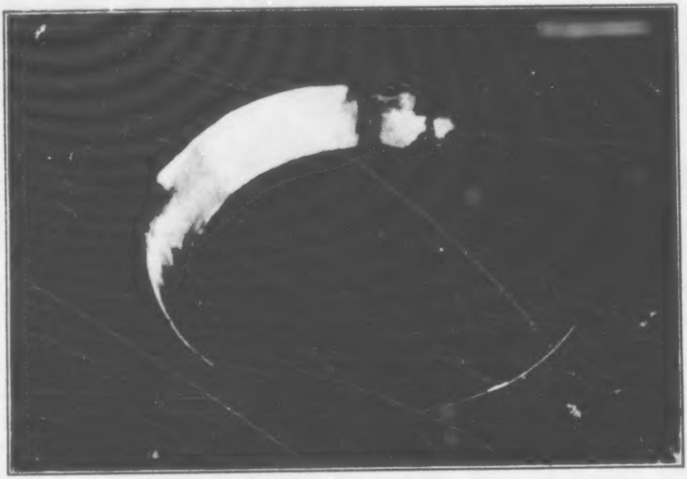


FIGURE 32

Picture 13: plate

Picture 13: plate (Figure 32). Brass plates such as this are common household items and are used twice a day for eating rice throughout most of Nepal. Nevertheless, this rather abstract perspective rendering caused a considerable degree of difficulty, being incorrectly identified by fifteen respondents. Incorrect identifications are given in Table 10.

TABLE 10

INCORRECT RESPONSES TO FIGURE 32

A tire	2 protocols
A phonograph record	2 protocols
An egg	2 protocols
The Earth	1 protocol
A clay pot	1 protocol
A cooking pot	1 protocol
A bell	1 protocol
Don't know	5 protocols

Misinterpreting the oval shape would cause respondents to see the picture as an egg. If attention is focused on the lines making up the design on the bottom of the plate, the impression of a phonograph record might be given. In a similar manner, the other erroneous interpretations are not entirely arbitrary, but are in one way or another indicated by certain details of the picture.

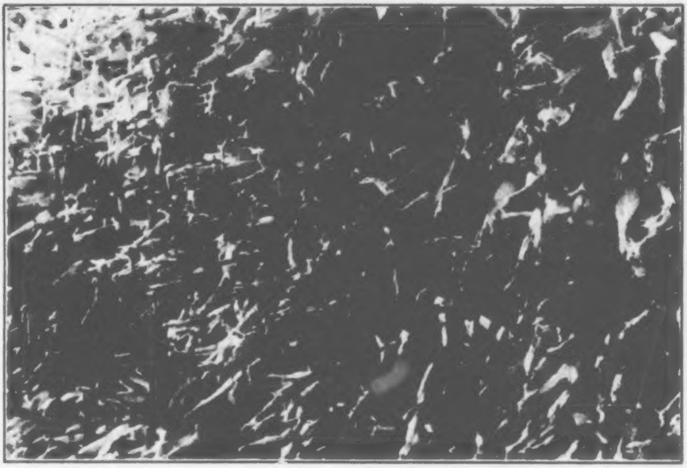


FIGURE 33

Picture 14: corn

Picture 14: corn (Figure 33). Corn is commonly hung in bundles or stacked for drying. The rather abstract detail does not reveal any contextual setting; nevertheless almost 60% of the respondents were able to give a correct identification. The sixteen subjects who were unable to identify the picture gave the responses shown in Table 11.

TABLE 11

INCORRECT RESPONSES TO FIGURE 33

Ducks, chickens or birds	7 protocols
Jungle, tree, plant	3 protocols
Wood	1 protocol
Peppers	1 protocol
Don't know	4 protocols

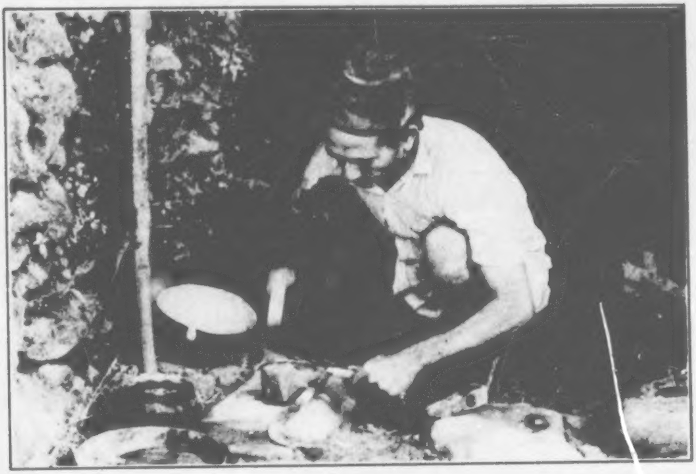


FIGURE 34

Picture 15: blacksmith

Picture 15: blacksmith (Figure 34). All respondents identified the person, but nineteen, half of the subjects, were unable to say what he was doing. Acceptable answers were: a blacksmith, doing iron work, welding, making or repairing a sickle, making or repairing tools. Incorrect responses are listed in Table 12.

TABLE 12

INCORRECT RESPONSES TO FIGURE 34

Cooking, making tea or bread	8 protocols
Making pots or dishes	3 protocols
Farming	2 protocols
Cutting wood	1 protocol
Don't know	5 protocols

Without careful analysis of small details, several of these interpretations are plausible. The blacksmith's hammer is depicted head on and is somewhat blurred because of the motion. The sickle he is working on is small and unclear. The pots and pans spread about might give the overall impression he is preparing food. While half of the respondents misinterpreted the action of this picture, it should be borne in mind that the other half interpreted it correctly.

Scoring

Subjects were graded according to the number of errors made, the number of times they hesitated for at least thirty seconds or turned the picture about in various directions before making a correct response and finally according to non-essential identification errors (such as the number of chicks in Picture 11 or the number of ducks in Picture 10). The first digit of a respondent's score was the number of errors; the second digit the number of hesitations or changes in orientation; the third digit was the number of nonessential identification errors. Thus a score of 231 would indicate two errors, three hesitations on pictures correctly identified and one nonessential mistake. Rank order was established on this basis with the lowest numerical score occupying the highest position (see Table 13). A quantitative analysis of errors reveals a clear pattern both of skill on the part of the respondents in interpreting photographs and of the level of difficulty of individual pictures. Figure 35 shows that the better picture perceivers made errors on the most difficult photographs, while the easier photographs were misidentified by the poorest perceivers.

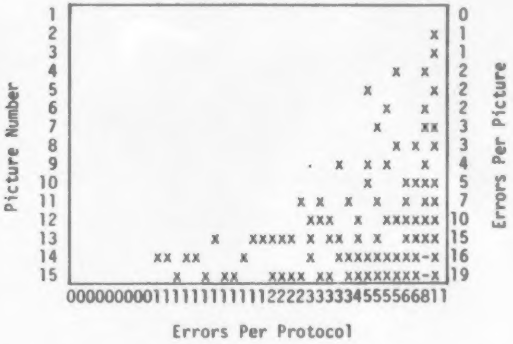


FIGURE 35

Identification of photographs: analysis of errors per picture and per respondent.

TABLE 13

SCORES AND PERCENTILE RANKING ON IDENTIFICATION OF PHOTOGRAPHS

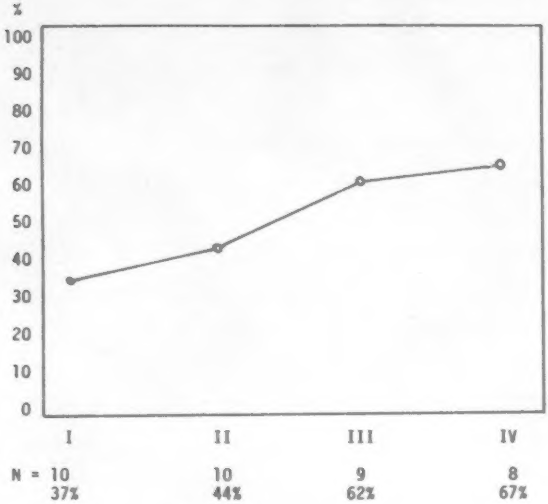
Protocol Number	Schooling	Literacy	Score	Percentile
4*	0	0	000	100
64	0	P	000	100
3*	0	0	001	95
63	0	P	001	95
35	X	L	010	90
16	0	P	011	87
32	IV	P	021	85
25	VII	L	041	82
23	IV	L	051	79
22	V	P	100	77
67	III	L	101	74
2	V	L	111	72
65	VIII	L	111	72
66	VII	L	111	72
8	0	0	112	64
13	VIII	L	112	64
20	V	P	121	59
30	X	L	121	59
62	0	P	131	54
24	VII	L	141	51
29	III	P	161	49
6	0	0	201	46
14	VIII	L	201	46
7	0	0	211	41
61	0	L	230	38
57	V	L	301	36
9	0	0	320	33
28	IV	P	321	31
60	0	0	321	31
15	0	0	330	26
5	0	0	411	23
11	0	P	501	21
21	0	P	511	18
17	0	P	512	15
26	0	0	531	13
1	0	P	611	10
12	0	0	631	8
59	0	P	800	5
33	0	0	1110	3

Code: Schooling: 0=no school; I-V=primary school; VI-X=secondary school.

Literacy: 0=illiterate; P=partially literate; L=literate.

*urban women

Dividing the village sample into four subgroups reveals the correlation between education and the ability to identify photographs. Subgroup I is composed of ten unschooled and illiterate subjects. Subgroup II is composed of ten unschooled but partially literate or literate subjects. Subgroup III is composed of nine subjects who have attended from three to five years of primary school. They are both literate and partially literate. Subgroup IV is composed of eight subjects who have attended secondary school up to the seventh class or beyond. All are literate. Averaging the percentile ranking of the members in each group, we can see in Figure 36 that the ability to recognize photographs is positively correlated to both literacy and education. The largest differential between subgroups appears between those having no school and those who have attended at least three years of primary school. It is worth noting, however, that the two urban women (not included in Figure 36), neither of whom were either literate or had attended school, both made no errors on identification and fell in the 100th and the 95th percentiles respectively.



I Unschooled and illiterate
II Unschooled and partially literate
III Primary school attenders
IV Secondary school attenders

FIGURE 36

Identification of photographs: percentile average according to educational status

Discussion

Correct identification of photographs of familiar objects and activities is definitely within the capability of most of these subjects Table 13 shows that half of the subjects made no errors or only one error and the next 25% made only two or three. The bottom quarter, making from four to eleven errors, could be considered poor picture perceivers. All of these latter respondents were unschooled, though more than half of them were rated as partially literate. Schooling cannot be counted as the only determining factor, however, as three out of the top four protocole (excluding the urban women which would make it five out of the top six) were from respondents who had not attended school. In fact, it is not possible to determine from the evidence here the reasons for good performance on this test. Education, intelligence, acculturation, and perceptual style are all variables with possible influence. The fact that the two unschooled and illiterate urban women scored so high is strong evidence that acculturation plays a significant role, but the urban sample is too small to make valid comparisons. A case for analytic perceptual style can be made by examining the eight respondents who correctly identified six chicks in Picture 11. Six of them were among the nine protocols making no errors and the remaining two were among those making one error. Finding six chicks in the picture is something akin to an embedded figures test. It is also interesting that none of the respondents who counted six chicks made errors on Picture 15, the blacksmith, which was the most difficult picture in the series to identify and one which also required careful scrutiny.

Taking a look at the pictures themselves, we can see in Figure 35 that the top 31 out of 39 respondents made only one error of identification on the first ten photographs. We have mentioned that the subjects of this study are probably better acculturated, not to mention better educated than the average citizen of Nepal, so that this proportion of correct identifications is undoubtedly high. Nevertheless, photographs of the type represented by the first ten appear to have a high chance of being correctly identified by a majority of villagers. The human figure seems to be consistently identified correctly, however actions are frequently misinterpreted. This appeared to be primarily due to misidentification of critical objects in the picture such as the baskets in Pictures 4 and 5, the spool in Picture 7, and the tools in Picture 15. In spite of other research that demonstrates the superiority of photographic "blackouts," these subjects seemed to have little difficulty separating an object from a confusing background, as in the cases of the calf (Picture 2), the hoe (Picture 9), and the buffalo (Picture 10). Abstract renderings were generally correctly interpreted, as in the case of the bananas (Picture 3) and the peppers (Picture 6). A number of respondents, however, had difficulty with the water (Picture 10) and sixteen were unable to identify the corn (Picture 14). The corn was stacked, however, and whole ears were not shown. Unlike the photograph of the peppers, careful scrutiny of this picture would still not reveal any complete exemplars of the object. The task is not so much one of visual discrimination as it is of inferring an ear of corn from the tip and the silk. Another test of inference was also poorly handled. Only the two Buddhist respondents were able to infer that the house in Picture 8 belonged to Buddhists because of the prayer flag. This would indicate that a sign (such as a flag) used to imply a meaning not directly shown in the picture (that the house belongs to Buddhists) will not be meaningful unless the sign is of immediate relevance to the observer himself. The flag is a failure as a symbolic visual cue. Finally, the high number of wrong identifications of the plate, a common household object, came as a surprise. In perspective the plate appears as an oval which, along with the contrast of light and shadow in what is normally perceived as an object of uniform color, may have rendered the photograph of the plate too abstract for easy identification. We have mentioned that drawings by inexperienced or primitive artists show a twisted perspective, sometimes known as a Lascaux perspective or naive realism. It is possible that if the mental image of a plate is as a round and uniformly colored object, this particular rendering is so unusual that the idea of its being such a simple and obvious thing as a plate never occurred to almost 40% of these respondents.

Experiment 2: matching pictures to models of animals

Materials and procedures

Ten model animals in realistic colors were presented one at a time and the subject was asked to name each one. The animals were a cow, a bull, a horse, a donkey, a sitting horse, a calf, an elephant, a tiger, a sheep and a pig, manufactured by Britains Ltd. of England. Each subject was then shown a series of twenty pictures and asked which animal among the ones just named was shown in the picture. Unlike Deregowski's experiment where only photographs were used, the pictures in this series consisted of seven photographs, seven line drawings and six cartoons. Subjects were encouraged to pick up the models and examine them if they were uncertain of the answer.

Subjects

Thirteen subjects completed this experiment. Eleven of them were villagers and two were urban women. Eight of the villagers were unschooled, two had attended primary school, and one had completed eighth grade. Seven of the unschooled villagers were also illiterate and one partially literate. Of the schooled subjects, one was partially literate and two literate. The urban women were both unschooled and illiterate. Only thirteen subjects were tested as it was found that the task was generally not difficult and that it correlated highly with the previous one. It was felt that the experiment gave little new information about the ability of the subjects to identify pictures, so it was eliminated from the test battery in order to leave more time for other experiments. The significant findings of the present test are the relative performances of the photographic, line drawing and cartoon styles.

Results

Two subjects had difficulty identifying the model animals. In one case the subject, an illiterate village woman, called the cow a deer, the calf a goat, and could not identify the sheep. When it came to matching pictures to the models, however, she made only two mistakes. Another subject, an illiterate man, was able eventually to name all of the animals, but with difficulty. When shown the pictures, however, he correctly named the cow, but pointed to the bull; the horse but pointed to the donkey; and the donkey, but pointed to the horse. These mismatches were counted as errors even though the errors were only minor ones and the misperceptions appeared to center on the models rather than on the pictures. The pictures are presented in order of difficulty. The order of presentation may be found in the Appendix.

No errors of matching or identification were made on the photographs of the horse (a), the sheep (b), the tiger (c), the drawing of the elephant (d) or the cartoon figure of the elephant (e) shown in Figure 37.

One error was made on each of the eight pictures in Figure 38. The photograph of the pig (a) was called a sheep and the photograph of the sitting horse (b) was called a donkey, even though the model donkey was standing. Confusion between the horse and the donkey was common. The drawing of the horse (c) as well as the drawing of the sitting horse (d) and the cartoon figure of the horse (e) were each misidentified as donkeys. The cartoon figure of a cow (f) was, interestingly, also called a donkey. One subject could not decide whether the cartoon figure of the pig (g) was an elephant or a bull, and finally decided it, too, was a donkey. The cartoon figure of the tiger (h) was called a dog by one respondent.

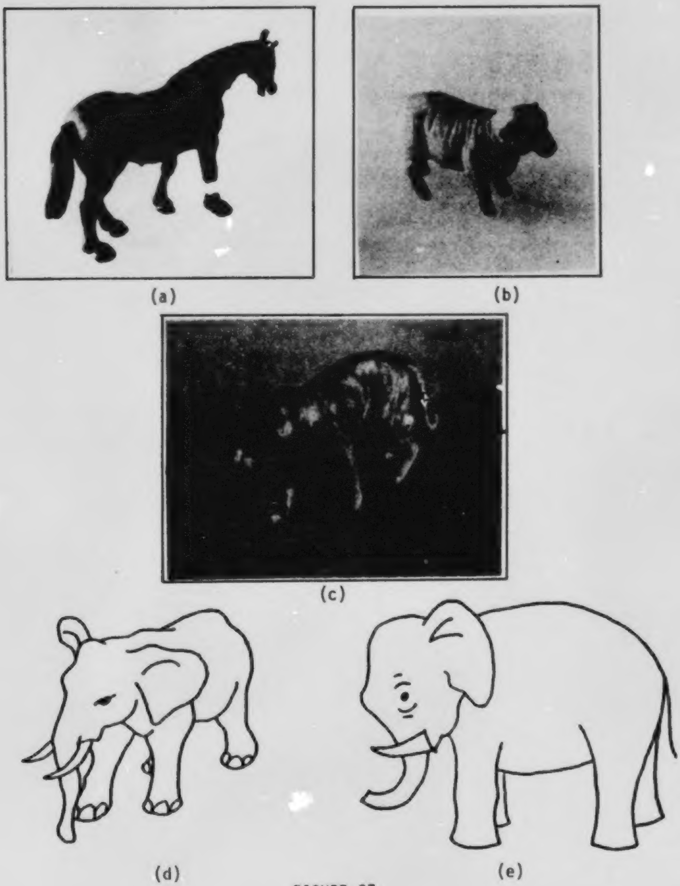
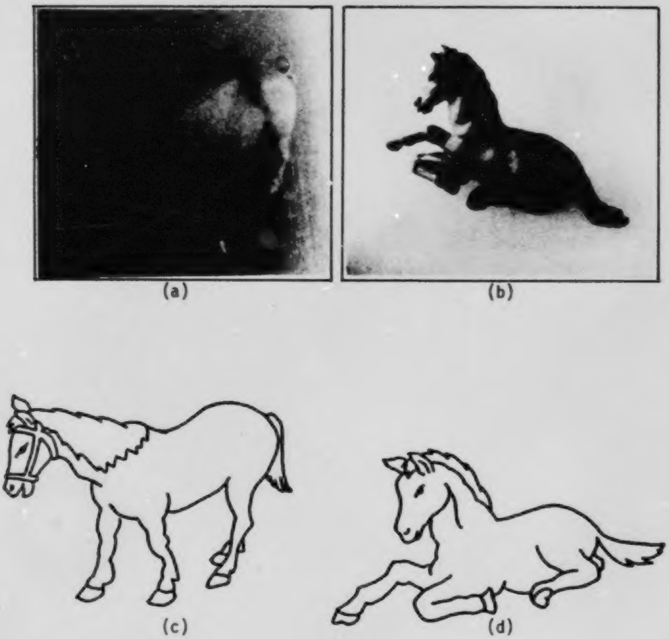


FIGURE 37

Pictures correctly matched by all respondents.


(a) (b)

(c) (d)

FIGURE 38

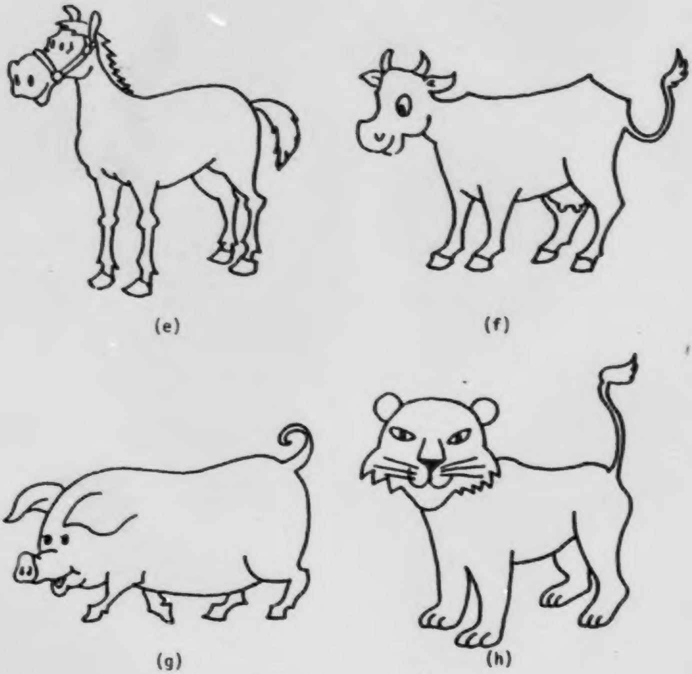
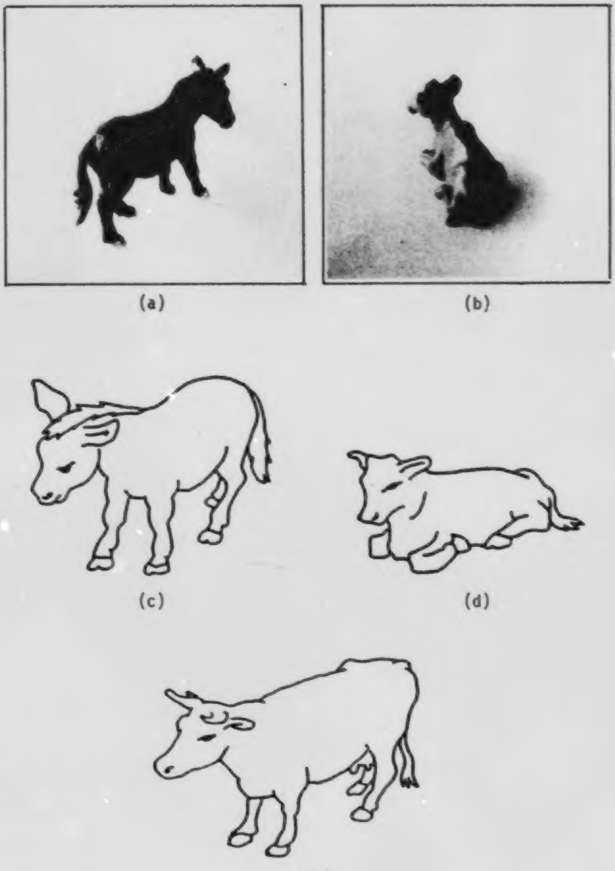


FIGURE 38--Continued

Pictures on which one matching error was made.

The pictures in Figure 39 were each misidentified twice. The photograph of the donkey (a) was twice called a horse, and the photograph of the calf was identified once as the sitting horse and once as a dog. The drawing of the donkey (c) was called a sheep by one



(a)

(b)

(c)

(d)

(e)

FIGURE 39

Pictures on which two matching errors were made.

respondent and another could not say what it was. The drawing of the calf (d) was called a she-goat and an ox, neither of which was present among the models. Finally, the drawing of the cow (e) was called a bull by one, while another, although identifying it as a cow, pointed to the bull.

The drawing of the bull (Figure 40) was misidentified three times, on each occasion being called a cow, in spite of the obvious feature of the ring in its nose. One of these subjects, while calling it a cow, actually pointed to the bull, a problem of naming more than of identification.

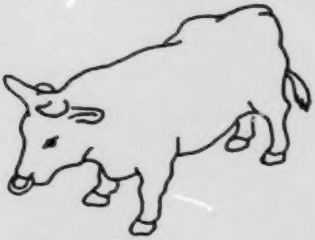


FIGURE 40

Drawing of a bull: identified as a cow by three respondents.

The cartoon figure of a sheep (Figure 41) was in a class by itself, being missed nine times. On six occasions it was called a goat, an animal not present among the models. It was also identified once each as a cat, a calf and a pig.

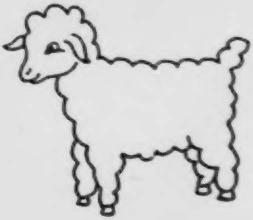


FIGURE 41

Cartoon figure of a sheep: misidentified nine times.

Scoring

Protocols were ranked, as in the previous experiment, according to errors made, with hesitations of thirty seconds or more on correct responses being incorporated as the second digit of a two digit score. Errors in either naming or matching were counted as incorrect. The rank order of protocols is shown in Table 14.

TABLE 14

SCORES AND PERCENTILE RANKING ON MATCHING PICTURES TO MODELS OF ANIMALS

Protocol Number	Schooling	Literacy	Score	Percentile
2	V	L	00	100
13	VIII	L	01	92
3*	0	0	10	85
8	0	0	11	77
4*	0	0	12	69
5	0	0	20	62
7	0	0	21	54
29	III	P	23	46
6	0	0	25	38
1	0	P	30	31
9	0	0	30	31
18	0	0	50	15
15	0	0	80	8

*urban women

Out of a total of thirty errors made, 13 or almost half were made by two respondents. The other eleven averaged approximately 1.5 errors each out of a possible twenty. It can be seen that this test was not difficult for the subjects participating in the study. Twelve respondents completed both this experiment and the previous one. A comparison of their percentile rankings on the two tests is shown in Figure 42. The close correlation between the results of the two tests shows that they are assessing substantially the same ability. Half of the respondents performed comparatively better on the identification experiment while half performed comparatively better on the matching test.

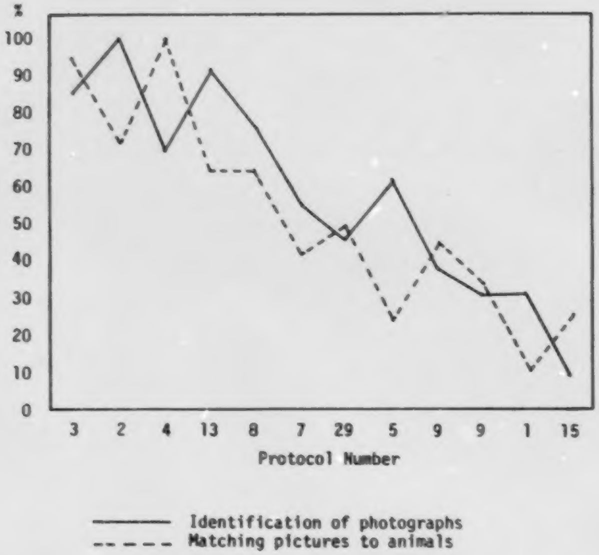


FIGURE 42

Comparison of percentile scores on identifying photographs and matching pictures to model animals

Discussion

In the present experiment the top two protocols were the two literate subjects. A case might be made that the demands of literacy facilitate the kinds of discriminatory skills required for this matching test more than they do the skills needed for the identification of photographs; however, the sample is too small to draw any conclusions of this kind. It will also be noted that the two partially literate subjects fell on the bottom half of the scale.

Of paramount interest in this experiment is the comparison between the photographs, the line drawings and the cartoon figures. To what extent are they equivalent in their power to communicate to village subjects? An analysis of the results gives the photographs a slight edge over the other two forms. Out of a total of 91 responses the photographs were correctly named and matched to the animals 83 times, giving a performance rate of 91%. Out of the same total number of responses the line drawings were correctly matched 76 times, giving a performance rate of 84%. There were only six cartoon figures, giving a total of 78 responses. Out of these 65 correct matches were made, giving a performance rate of 83%. Had it not been for the poor performance of the cartoon figure of the sheep, which was missed by two-thirds of the respondents, the performance of the cartoons would have surpassed that of the line drawings and possibly even that of the photographs. This interesting finding deserves a note of explanation.

Cartoon figures and caricatures exaggerate certain structural features of an object. That distortions of this kind do not cause a failure in communication is evidenced by the high rate of correct identifications shown by these village subjects, almost none of whom, it could be safely surmised, had ever had opportunities to acquaint themselves with cartoon figures. The stretching and bending involved in cartoons preserves important structural elements. In a similar vein, we learn during infancy that certain structural properties of an object remain invariant in spite of changes in distance, orientation or illumination. These are called perceptual constancies. It is more than likely that a similar principle of structural invariance in the face or nonessential changes makes the cartoon figures intelligible. We shall see in the next chapter that euclidean concepts such as similarity and proportion emerge late in the development of spatial understanding, whereas topological notions such as proximity, separation, order and enclosure are among the first developed. The distortions of cartoon figures are essentially topological, as the underlying structural relationships are preserved. It is quite possible, even, that the distortions of the cartoon figures went entirely unnoticed by the sample tested. Certainly none of the subjects mentioned the lack of realistic detail. The cartoon figure of the sheep apparently introduced elements more akin to arbitrary conventions than to simple distortions.

Experiment 3: counting cubes and making simple constructions

Materials and procedure

Prior to this experiment each subject was shown a 1 1/2 inch wooden cube and asked to draw a picture of it. The results of that experiment will be reported in the next chapter. Ten wooden cubes were then spread out on the table or mat where the experiments were being conducted. The subject was shown twenty pictures, drawings and photographs, each depicting from one to eight cubes in a variety of configurations. For each picture the subject was asked, "How many blocks of wood like these (referring to the cubes) do you need to make this?" There is no common word in Nepali for cube. At the experimenter's discretion the subject was given the stated number of cubes and asked to arrange them in the configuration shown in the picture. Requests for constructions were made both in cases where the correct number of blocks was given, in order to see if the configuration was properly understood, and in cases where the wrong number was given, to see if the act of construction itself would enable the subject to correct his answer. In a few cases the subjects spontaneously took the blocks and made constructions without being asked.

Subjects

Forty-two village subjects, two urban women, ten workers in a furniture factory and ten engineering students were tested. Of the forty-two village subjects, two were given seventeen out of the twenty items and ten were given, in the interests of time, only the first ten items. Another seven respondents were given only the first three to eight items after which testing was suspended because they missed all or almost all of the questions and further testing would have produced only more of the same.

Results

The order of difficulty of the pictures was determined on the basis of the 45 complete protocols, but the performance of all 64 protocols will be mentioned in reporting the results. The actual order of presentation during the experiment is given in the sample questionnaire in the Appendix.

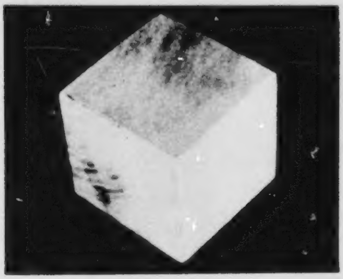


FIGURE 43

Picture 1

Picture 1 (Figure 43). This photograph of a cube was missed by eight respondents. Five said it was three cubes, two said it was two cubes, and one said it was four cubes. Of the respondents who were shown this picture, 88% perceived it correctly.

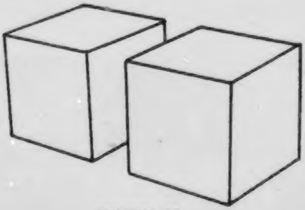


FIGURE 44

Picture 2

Picture 2 (Figure 44). This drawing of two cubes was misinterpreted by nine respondents. Four said they saw six cubes, three reported four cubes, and one each saw three cubes and one cube respectively. One of the respondents who reported six cubes was asked to construct the figure. He took eight and arranged them in two blocks of four. Of the subjects who were shown this picture, 86% perceived it correctly.

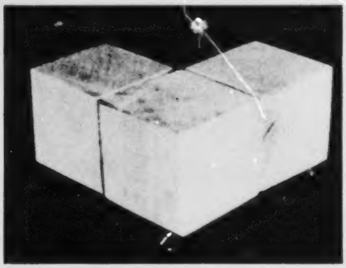


Figure 45

Picture 3

Picture 3 (Figure 45). Four errors were made. One respondent, apparently counting the visible faces, reported seven cubes. Out of eleven constructions three made various errors. Of the total number of subjects who were shown this picture, 93% gave correct answers.

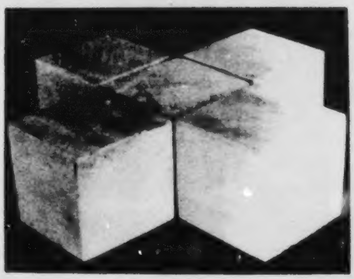


FIGURE 46

Picture 4

Picture 4 (Figure 46). One respondent saw only four cubes. Out of nine constructions two made errors such as shown in the diagram in Figure 47. This picture was correctly perceived 95% of the time.

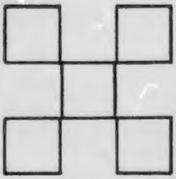


FIGURE 47

Example of a construction error made in response to Figure 46.

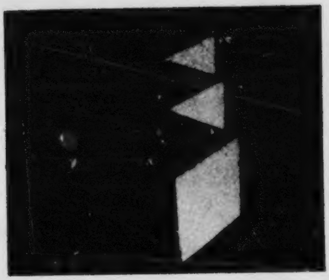


FIGURE 48

Picture 5

Picture 5 (Figure 48). All respondents counted three blocks. Out of fourteen constructions, however, three made errors. In two of these cases the blocks were not touching. This picture was understood 94% of the time. However, if more constructions had been requested it is likely a fair number of additional errors would have been made.

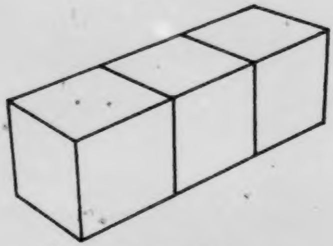


FIGURE 49

Picture 6

Picture 6 (Figure 49). Of fourteen errors, ten reported seeing seven cubes in this picture. Obviously they were counting the visible faces. Two respondents saw only one cube and one reported five cubes. The fourteenth error was the result of an onlooker whispering the answer to the respondent. It was evident to the experimenter that he would not have given a correct solution. Seventy-eight percent of the respondents perceived this picture correctly.

FIGURE 50

Picture 7

Picture 7 (Figure 50). Fifteen errors were made. In fourteen cases the subjects reported two blocks and in one case four blocks. The picture was correctly perceived by 76% of the respondents.

Picture 8 (Figure 51). Out of fifteen errors, thirteen respondents identified this picture as three blocks. The remaining two reported two blocks and four blocks respectively. This picture was correctly perceived 75% of the time.

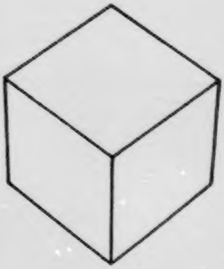


FIGURE 51

Picture 8

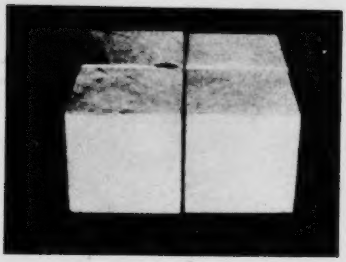


FIGURE 52

Picture 9

Picture 9 (Figure 52). All eighteen errors reported this picture as showing two blocks. The bold line separating the left hand side from the right was obviously seen, but the subtler transverse line separating the rear blocks from the front ones went unnoticed. Seventy percent of the respondents saw this picture correctly.

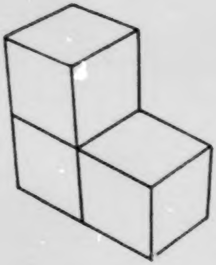


FIGURE 53

Picture 10

Picture 10 (Figure 53). Out of four errors of counting, three respondents reported seven cubes and one two cubes. Again the respondents seeing seven cubes were counting the visible faces. Out of 26 constructions five errors of various kinds were made. In three of these cases the blocks were all placed horizontally on the table. This picture was correctly perceived 83% of the time.

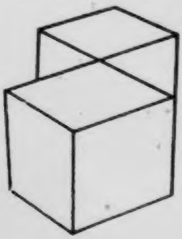


FIGURE 54

Picture 11

Picture 11 (Figure 54). Out of nine counting errors, three reported six cubes, three saw four cubes, two saw one cube and one counted five cubes. Out of 25 constructions, nine errors were made; in six cases respondents produced configurations such as shown in the diagram in Figure 55. One respondent who had counted four cubes corrected his count after making a construction. Seventy percent of the subjects shown this picture gave correct answers. More constructions, however, might have produced similar errors of the kind shown in Figure 55.

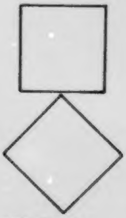


FIGURE 55

Example of a construction error made in response to Figure 54.

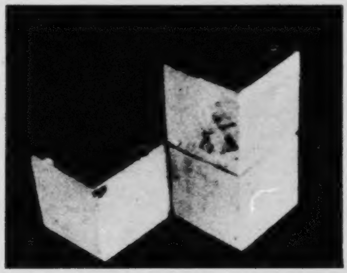


FIGURE 56

Picture 12

Picture 12 (Figure 56). All ten counting errors reported only three cubes, failing to take note of the block partially hidden in shadow. An additional three errors were made during eighteen constructions. One of these constructions was essentially correct but reversed. This picture was understood by 72% of the respondents who saw it.

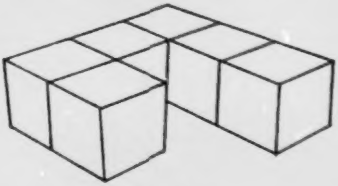


FIGURE 57

Picture 13

Picture 13 (Figure 57). Eleven errors of counting were made. Responses included 13 cubes (three times) and 12 cubes (twice). These subjects were again counting the faces. Two respondents each gave counts of seven blocks and five blocks and one each said 10 blocks and 2 blocks. In addition to the counting errors, three construction errors were made out of 18 tries. One of the subjects who had counted seven blocks corrected his count after making a construction. This picture was correctly perceived 72% of the time.

Picture 14 (Figure 58). Out of eleven counting errors, eight respondents reported that only six cubes would be required to produce this configuration. They were counting only the visible blocks and not taking account of the one that is hidden. Two of these respondents, however, corrected their counts after constructing the model. The

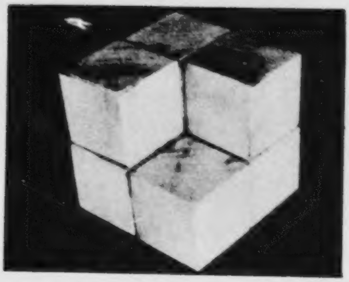


FIGURE 58

Picture 14

remaining three counting errors were three blocks (twice) and one block (once). Out of twenty constructions, one of the respondents who reported seven blocks was unable to produce a correct model. Of the subjects who were shown this picture, 73% responded correctly.

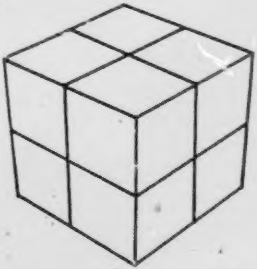


FIGURE 59

Picture 15

Picture 15 (Figure 59). Out of fifteen erroneous responses eleven reported that the figure contained twelve blocks. Here again, it is the number of faces that was being counted. One respondent each reported the figure as having 7 blocks, 6 blocks, 4 blocks and 1 block. Three respondents corrected their counts while making constructions. Only 68% of the respondents shown this picture perceived it correctly.

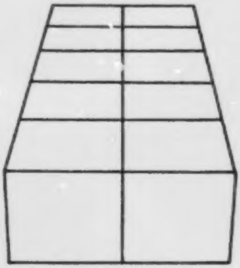


FIGURE 60

Picture 16

Picture 16 (Figure 60). Out of twenty counting errors, sixteen respondents reported twelve blocks, not realizing that two faces of the front pair of blocks are visible. Two counted only six blocks and one seven blocks. One respondent who reported ten blocks piled them vertically on top of one another. Fifty-seven percent of the respondents answered the question correctly.

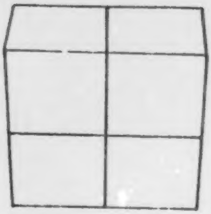


FIGURE 61

Picture 17

Picture 17 (Figure 61). Twenty-nine respondents counted six blocks in this picture. Eight of them made constructions showing three pairs of blocks laid horizontally front to back. Two made constructions with three pairs of blocks piled on top of each other in vertical fashion. A total of 36 constructions were made. Ten respondents who counted four cubes, nevertheless proceeded to lay the configuration on the table horizontally. This was the most poorly understood picture in absolute numbers of the entire series, being correctly perceived a mere 34% of the time. A great many of these errors, however, were on incomplete protocols. When complete protocols are considered alone, this picture fared better than the next three.

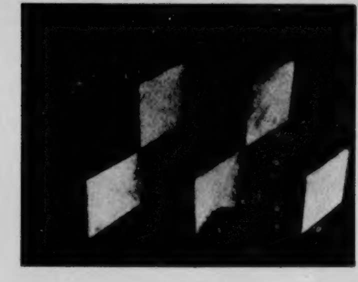


FIGURE 62

Picture 18

Picture 18 (Figure 62). Out of nineteen errors in counting, eighteen said it would take five blocks to produce this model and one said it would take six. Those giving answers of five blocks were not taking into consideration how the two blocks in the rear were being supported. Five of these respondents made constructions by actually holding the two latter blocks suspended in the air. Three corrected their count while making constructions. Three additional respondents stated that eight cubes would be required, which is a possible answer and their constructions showed one cube hidden behind without another on top. They were given credit for this solution. Out of thirty-one constructions two further errors were made by subjects who had counted seven blocks. This picture was understood by 53% of those asked.

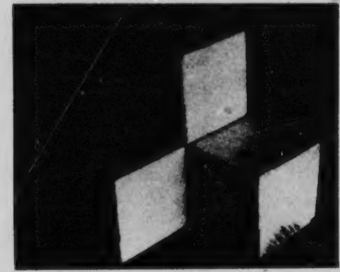


FIGURE 63

Picture 19

Picture 19 (Figure 23). Twenty-five respondents said it would require three cubes to construct this figure. Ten respondents actually held the uppermost block suspended in the air while making their constructions. Seven, however, corrected their counts and added a fourth block while constructing the model. Thirty-five subjects were asked to construct this figure. Of those that had said it would take four blocks to make, three were unable to arrange them in the configuration shown. It is interesting to note that six more counting errors were made on this picture than on the previous one whereas the opposite would have been expected. This picture was actually presented earlier in the series than Picture 18 and it is possible that some learning could have taken place. This would most certainly be the reason in two instances. There were three cases where subjects who suspended the uppermost block in the air on Picture 19 were shown by the experimenter how an extra block, hidden from view, would complete the construction. Two of these subjects, at a later point in the experiment, went on to make correct constructions of Picture 18. Three of the seven subjects who corrected their counts themselves while making constructions also went on to give correct answers for Picture 18, an example of learning by doing. Only 40% of the respondents who were shown this picture were able to interpret it correctly.

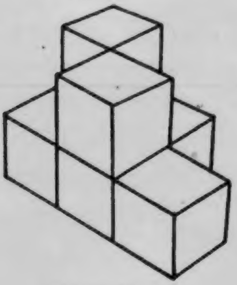


FIGURE 64

Picture 20

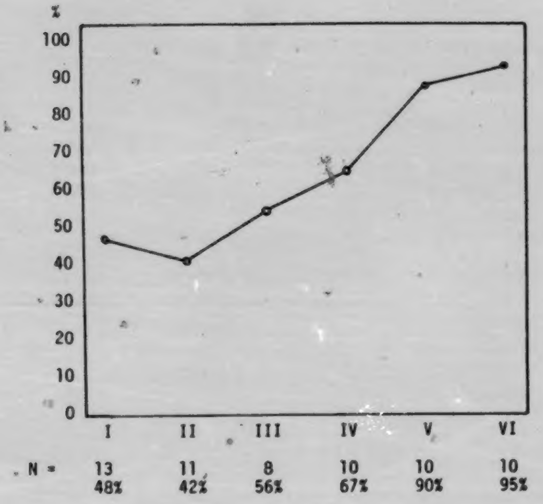
Picture 20 (Figure 64). Twenty counting errors were made. Nine subjects counted six cubes, those that are visible. Three each counted five and eight cubes, two reported twelve cubes and one each reported three, eleven and fourteen cubes. It is difficult to know where these numbers came from, but presumably the subjects were counting faces in most instances. Apparently faces that were partially masked were not included in all but one of these counts as a total of fourteen complete or partial faces are visible. Out of 31 constructions an additional 6 respondents who had given answers of seven were unable to duplicate the model. Two other respondents, however, corrected erroneous counts while constructing this figure. Only 42% of the respondents were able to demonstrate an understanding of this picture.

Scoring

An error was marked for either a mistake in counting or a faulty construction or both. Out of a total of 302 errors 49 were instances of correct counts followed by faulty constructions. If more constructions had been solicited, certainly more errors of this kind would have been made. There were nineteen instances of counts being corrected after constructions were made. These were noted but the items were nevertheless marked as errors. Each subject's percentage score was calculated on the basis of how many correct answers were given out of the total number of items completed. Thus the scores of the nineteen incomplete protocols were judged on the basis of the items which were done. In the cases of the ten respondents completing only half of the test this would lead to a percentage score slightly higher than they might otherwise have attained, as the second half of the test included more difficult items. For this reason and because of the previously mentioned fact that a considerably higher number of construction errors would have been made if more had been requested, the scores give only approximate levels of performance.

A total of 310 constructions were made. In a majority of cases (191) correct counts were confirmed by correct constructions. In another 51 instances incorrect constructions combined with erroneous counts confirmed misperception of the pictorial cues. Thus in 242 cases (or 78%) the construction task confirmed the results of the counting exercise. In 49 cases (or 16%) seemingly correct responses were invalidated by failures to produce a correct model. The correct number may have been arrived at by guess or by intuition, but the construction task showed that the picture was not completely understood. In a small minority of instances (19 cases or 6%) wrong counts were corrected during construction, showing the learning effects of the construction task.

For purposes of intergroup comparison the entire sample has been divided into six subgroups. Subgroup I (N=13) is composed of unschooled, illiterate villagers. Subgroup II (N=11) is unschooled villagers who are literate and partially literate. Subgroup III (N=8) is made up of literate and partially literate villagers who have attended up to five years of primary school. Subgroup IV (N=10) consists of literate villagers all of whom have completed at least seventh grade in secondary school. Subgroup V (N=10) is the workers in the furniture factory in Kathmandu. Finally, Subgroup VI (N=10) is comprised of students at the Institute of Engineering in Kathmandu. Figure 65 shows the average level of performance by each of these groups.



I	Unschooled and illiterate
II	Unschooled and partially literate
III	Primary school attenders
IV	Secondary school attenders
V	Furniture factory workers
VI	Engineering students

FIGURE 65

Percentage of correct answers per subsample on counting and construction test

Discussion

This experiment was found to be considerably more difficult for the village respondents than the previous two. Figure 66 compares

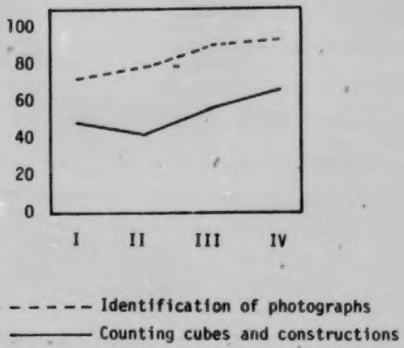


FIGURE 66

Percentage of items correctly identified in Experiments
1 and 3 by village subsamples

the performance of the four village subgroups on the first experiment and the present one in terms of absolute percentages of items correctly identified. It is evident that on the counting and construction experiment abilities other than simple picture recognition are involved. A number of causes might be responsible for the relatively poor performance in the test involving cubes. One would be unfamiliarity of the test materials. Whereas animals such as those used in the matching test are objects of everyday knowledge, blocks of wood are not. We have already mentioned that there is no common word for cube in Nepali. Absence of such a word, furthermore, according to Berry's thesis, might be an indication that the spatial and structural properties that characterize cubes (right angles, parallel lines, equal lengths) are not particularly relevant in Nepalese village culture. If lack of familiarity with the test materials is a factor, however, it is not the only one. According to Figure 65, performance improves gradually with education. Village adults who have attended even a few years of primary or secondary school show higher average levels of performance. It could hardly be argued that their school experience has made them more familiar with cubes. For the same reason the carpenteredness of the environment can be discounted as the controlling variable. All of the villagers are familiar with rectilinear objects in the form of tables, beds, doors, windows, and rectangular houses. Education, by itself, also does not account for the findings. The furniture factory sample is, on the whole, less educated than the secondary school villagers. So are the two illiterate urban women (not shown in Figure 65) both of whom scored higher than the average of the highest village subsample. If the urban women are combined with the furniture factory workers, an urban subsample of twelve subjects is obtained, six unschooled and six with three to ten years of schooling. The six unschooled urban subjects scored an average of 83% correct, while the schooled subsample scored 94%. Again, schooling seems to produce a slight edge but the high score of the unschooled group shows that schooling alone will not account for the variations in performance. A strong argument could be made for acculturation as a significant variable. Specific experience or training can also be cited as a critical factor. The engineering students had themselves graduated from village high schools only one or two years previously, but had studied projective drawing as part of their coursework. Specific training of this kind enabled this entire group to interpret the pictures correctly 95% of the time, while only one of the village subjects (an eighth grade graduate) was able to perform at this level. In summary, then, we might ask whether the skills required for this test are primarily perceptual or primarily cognitive in nature? In order to answer this question we will look briefly at the kinds of errors that were made.

The most common single error was to count the faces of the blocks instead of the entire units. This error derives from a failure to understand and apply the cues of perspective drawing. A comparison of the performances of the photographs and the line drawings will help to elucidate this important matter. The series of pictures was divided arbitrarily into photographs and line drawings, with each format alternating in the original presentation. On the whole the photographs were perceived more accurately than the line drawings. In order to demonstrate this we can give each picture a numerical value equivalent to its place number when the pictures are arranged in order of difficulty. By totalling the combined place numbers of the photographs we arrive at a figure of 92, while the combined total of the line drawings comes to 118. We can see that the line drawings tended on the average to fall among the higher place numbers or toward the more difficult end of the scale. Another indication that the photographs were more readily understood can be found by comparing the results of Picture 1 and Picture 8. These are the only two pictures in the series that are identical, save for the fact that one is a photograph and the other a line drawing. Five respondents said that the photograph was three blocks, whereas thirteen respondents identified the line drawing as three blocks. In fact, nine of the thirteen who missed the line drawing identified the photograph correctly! During experimentation the photograph always preceded the line drawing so that learning can be discounted. In fact, learning factors should have worked in the opposite direction. Similarly, a comparison of the results of Picture 9 and Picture 17 shows errors of two very distinct and differing types. In the case of Picture 9, a photograph of four cubes arranged horizontally, all eighteen mistaken protocols reported two cubes. In the case of Picture 17, a line drawing of four cubes arranged vertically, all twenty-nine mistaken protocols reported six cubes. The two pictures are essentially the same, but the responses to them are entirely different. Furthermore, an analysis of the results of all twenty pictures reveals that in the case of the line drawings more than a hundred of the errors made were of the type where individual faces of the blocks were counted while no more than twenty errors of this kind are found among the responses to the photographs. From these findings two important conclusions can be drawn. The first is that in this experiment the photographs give qualitatively better information than do the line drawings. Shading and texture aid in the correct perception of these materials. The second conclusion is that the cues of perspective which these pictures utilize are understood only at an intuitive level by many of these villagers. The faithful rendering of the photographic medium appears to give an accurate impression which results in a greater number of correct responses. When these same cues are used in the more schematic medium of line drawings, however, they cannot be utilized. Perspective cues are inadequate by themselves without the supplementary cues of texture and shading precisely because they are understood intuitively and are not consciously grasped. While watching the subjects construct these models the experimenter observed that in a great many cases a trial and error approach was used. While erroneous counts were corrected in only nineteen instances through construction, it is an astonishing fact that in 100 cases subjects were satisfied with false constructions. They could not differentiate between their constructions and the figures because they were incapable of appreciating the cues given in the pictures. Conscious awareness and application of perspective cues seems to be the single most important factor in the successful handling of this test. Witness the improvement in performance of the engineering students over the educated village subsample. Training in specific pictorial cues, however, does not account for all of the variations in performance. Sheer familiarity with pictures or with wooden blocks seems to help, as witnessed by the fairly high performance of the urban women and the furniture factory workers, half of whom were unschooled.

A very different cognitive problem was presented by the five pictures where one of the blocks needed to complete the structure was hidden (Pictures 14, 15, 18, 19, and 20). At least sixty errors were made where the hidden cube was not taken into consideration when a count was given. Three of these five pictures were photographs. In the case of Picture 14, eight out of eleven errors were of this kind, where respondents counted six cubes instead of seven. In Picture 18, eighteen out of nineteen errors were of this kind. And in Picture 19, all twenty-five errors were of this type. In the case of the two line drawings, Pictures 15 and 20, the ratio of this type of error to the total was much lower--one out of fifteen and nine out of twenty. No doubt this is because in these two pictures, especially Picture 15, errors of the kind where faces of the cubes were counted made it impossible for subjects to appreciate the problem of whether an extra cube was hidden behind the others or not. It is interesting that out of the nineteen corrections made during constructions, seventeen were made in connection with these five pictures (seven in the case of Picture 19, three each in connection with Pictures 15 and 18, and two each in connection with Pictures 14 and 20). It is remarkable that the construction exercise did not produce a single correction in cases where the error was one of counting faces rather than entire blocks. The nineteen corrections were made by twelve different respondents, eight of them villagers, two of them factory workers and two of them engineering students. Taking a look at the eight village respondents who made corrections, two were unschooled, three had attended primary school, and three had attended secondary school. Their performances on the rest of the test were not remarkable. Two made 12 errors each (performing at a level of only 40%). Another two made nine errors each (55%). Two others received scores of 75% and the last two 80%. Thus, a fairly representative cross-section of village respondents was able to correct errors of this kind. It is noteworthy that most of these same respondents who made corrections on one of the five pictures containing a hidden block also made errors of counting based on the number of faces showing. Two of them even reported seeing three blocks in Picture 8. This leads us to the conclusion that understanding a construction problem, such as that a hidden block is needed to complete a certain structure, is an easier task for these subjects than understanding cues of perspective.

It is an obvious fact that all of us are familiar with perspective phenomena. Rarely are objects seen head on, and in our everyday experience we are accustomed to interpreting ovals as circles seen obliquely and acute angles as right angles and so forth. We have all experienced the optical shrinkage of an object as a function of distance. Every optic array is a projection and thus every object in the optic array is seen from a particular perspective. But these phenomena are transparent to us. Our minds unconsciously compensate for the distortions of perspective. Because the principles of perspective are understood only at an intuitive level by many of these villagers, they cannot be utilized as pictorial cues. The pictures are understood intuitively rather than intelligently. The photographs give a more realistic overall impression; they look like cubes, and therefore they are more frequently perceived correctly. But if the overall impression does not reveal the answer, many of these subjects are helpless when it comes to analyzing the picture and interpreting the cues contained in them. Since the principles of perspective are not consciously grasped in the real world, they cannot be deliberately applied to the interpretation of pictures. Accurate perception, which seemed to take these subjects a long way in the previous two experiments, is not sufficient in the present case, where the cues of perspective are applied in essence, as it were, almost abstractly.

Here perception must be supplemented with understanding at a cognitive level. In the next chapter we will study the ability of these subjects to understand and apply spatial principles to pictorial material.

CHAPTER V

UNDERSTANDING PICTURE SPACE

In their landmark book, The Child's Conception of Space, Piaget and Inhelder demonstrate that the evolution of spatial understanding proceeds at two different levels--the perceptual level and the level of thought or imagination. In reviewing the current theories of perception in Chapter I we noted that most of the theories agree that the perception of space does not exist ready made in the newborn infant. For example, a child of seven or eight months does not think to reverse a feeding bottle presented the wrong way around. Awareness of the constancy of the shape and size of objects is completed gradually during the first year. As the coordination of vision and grasping improves, perceptual space becomes transformed and systematized. Objects are rotated, passed from one hand to another, all the while being looked at, and eventually they begin to acquire the properties of solid objects. According to Piaget and Inhelder the earliest spatial relationships understood by the infant are topological ones--proximity and separation, order or succession, enclosure or surrounding, and continuity. The development of size and shape constancy require the elaboration of euclidean and projective relationships. Euclidean relationships are metrical ones. Understanding that the size of an object remains constant throughout changes in position is an example of a euclidean concept. Projective relationships involve the various perspective views obtained by observing an object from various positions. Shape constancy results from coordinating these different views. As the child searches for objects, he becomes aware that they are permanent. The object begins to take on fixed dimensions and its shape and size are correctly estimated regardless of distance. In this fashion the development of shape and size constancy are a synthesis of metric and projective relationships. They develop jointly and interdependently.

While most of the theories of perception would agree upon this evolution of spatial understanding, Piaget and Inhelder postulate a second evolutionary process which repeats the development of perceptual understanding at the level of thought, a level which they refer to as representational space. Whereas perception is the knowledge of objects resulting from direct contact with them, representation involves the evocation of objects in their absence, through signs, such as language, or symbols such as images and gestures. The transition from perception to representation involves both images and thought. From two years of age the child's mental images begin to make delayed imitation possible. Thought now begins to take on the task of reproducing at the level of representation all of the same spatial relationships that were elaborated at the level of direct perception. One aspect of critical importance in the thesis advanced by Piaget and Inhelder is the fact that motor activity is at the basis of both perceptual and representational space. For example, the perception that a feeding bottle is turned the wrong way implies a system of relationships which constitute an organized whole. The whole includes not only the relationships actually perceived, but possible ones, such as anticipating the result of rotating the bottle. Such possible relationships presuppose motor activity. Thus, our interpretation of spatial information depends upon both figural and motor elements. A plate seen in perspective appears oval shaped to the eye; the idea of shape constancy implies the interposition of movements that would enable us to gain a head-on view of the plate. Thus, side by side with passive perception is perceptual activity which involves comparisons, transpositions and anticipations.

With both direct perception and the mental images of representation, the sense data act merely as pointers to various relationships, some of them real, some of them possible. It is internalized movement and organization, however, which give these pointers meaning. Thus, the understanding of spatial relationships is achieved, not from objects directly, but from the coordination of mental actions performed upon them.

In this chapter we shall examine the understanding of topological, euclidean and projective concepts in Nepalese adults and see to what degree these perceptual relationships are internalized and coordinated at the level of thought. We will look for ways to apply the findings to problems of communicating with pictures.

Topological Space

When we look at an object we receive a photographic impression of it. This does not mean that we are necessarily able to comprehend everything our eyes take in. For example, if we try to draw it, we can only extract from it those features which we are able to appreciate. According to Piaget, the study of drawings enables us to distinguish between visual perception and representation at the level of thought. As an activity, drawing is not simply an extension of perception, but involves the movements, comparisons, reconstructions and anticipations that Piaget identifies as perceptual activity. Drawings, therefore, do not tell us so much about perception as they do about perceptual activity itself.

The development of drawing skills in children proceeds through three stages, each one characterized by the kinds of spatial relationships that are grasped and applied. At the first stage, the stage of synthetic incapacity, euclidean relationships such as proportion and distance are ignored, as is perspective. Only topological relationships are observed. The child who draws a face with the nose above the eyes certainly does not perceive faces in that way. Nor is it through lack of skill or attention that he reverses the order of the facial elements. He does so, according to Piaget, because of the inadequacy of his instruments of spatial representation.

The second stage is that of intellectual realism. The child draws not what he sees but what he knows to be there. Drawings of this stage are characterized by a jumble of irreconcilable points of view and pseudo rotations, much like the previously mentioned Lascaux perspective found in primitive art. Jumbling points of view, however, requires a prior understanding of projective relationships. But during this stage these relationships are not coordinated.

The third stage of drawing is that of visual realism. According to Piaget it does not appear until late, around eight or nine years of age. During this stage the child is able to apply euclidean and projective relationships such as proportion, distance and perspective, to his drawings. These relationships are grasped much earlier, by two years old, on the level of perception, but are not mastered on the conceptual level until the period of concrete operations.

Experiment 4: drawing geometrical shapes

Materials and procedure

Subjects were asked if they had ever drawn a picture. They were given a clip board with a blank sheet of paper approximately 8½" x 13" and a pencil. They were then shown a series of geometrical figures taken from Piaget and Inhelder's The Child's Conception of Space (see Figure 67). The geometrical figures used in the experiment were approximately 2" high and were shown one at a time.

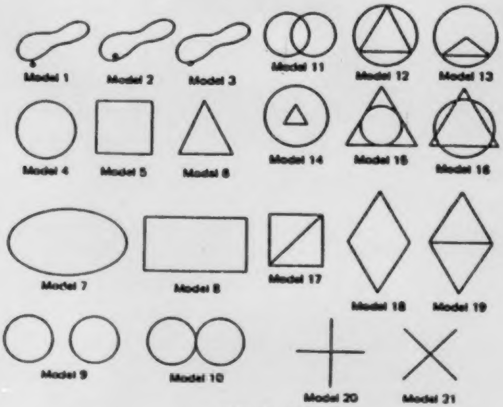

Model 1
Model 2
Model 3
Model 11
Model 12
Model 13
Model 4
Model 5
Model 6
Model 14
Model 15
Model 16
Model 7
Model 8
Model 17
Model 18
Model 19
Model 9
Model 10
Model 20
Model 21

FIGURE 67

Topological and euclidean shapes.
(Source: Piaget and Inhelder, The Child's Conception of Space, p. 54.)

Subjects

Forty-four village subjects, two urban women, ten workers at a furniture factory in Kathmandu and ten students at the Institute of Engineering, also in Kathmandu, were given parts of this test. The purely topological figures (Models 1, 2 and 3 and Models 9, 10 and 11) were given to only a few of the subjects. All were asked to reproduce the upright and the diagonal crosses (Models 20 and 21), the rhombus (Model 18), and three of the circumscribed figures (usually Models 12, 15 and 16) plus a variety of the other figures depending upon the experimenter's discretion.

Results

A number of the subjects said they could not draw, but with encouragement all of them relaxed after the first model and completed all of the figures they were asked to reproduce. Qualitative results will be described in this section based on the stages of development described by Piaget and Inhelder. Quantitative results will be described in the section on scoring.

Piaget and Inhelder describe three stages, along with substages and transitional stages, in copying geometrical figures. Stage I begins with scribbles and ends with the first global discriminations. Topological relationships such as proximity, separation, and enclosure are the only ones initially grasped, while euclidean relationships are entirely ignored. Thus open and closed figures are distinguished, but no distinction is made between straight and curved figures. The circle, the triangle and the square are all depicted as irregular closed curves. During the transition from Substage IB to Substage IIA straight sided shapes begin to be distinguished from curved ones, but without regard for the number of straight sides. Thus the square and the triangle are not distinguished. In order to connect a given straight line with another at a certain angle, one has to take into account such factors as length, distance, parallelism, inclination, the number of lines, points of contact and so forth. These are euclidean relationships and their coordination develops gradually throughout Stage II. In Substage IIA, the elements of the figures are differentiated, but adjustments are tentative. Oblique lines are discovered, enabling a distinction to be made between the upright cross and the diagonal cross. The circumscribed figures are reproduced fairly accurately in shape, but not in points of contact. By the end of Substage IIB the rhombus is mastered as are all of the circumscribed figures except for Model 16. During Stage III the child becomes able to draw all of the figures correctly without having to resort to trial and error. His mental image is elaborated sufficiently to allow him to anticipate measurements and coordinate lines. The elements of the shapes are put in proper relation as a result of the gradual mental coordination of his actions.

Models 1, 2 and 3 and models 9, 10, and 11. These six models reveal an understanding of topological relationships such as proximity, separation and enclosure or surrounding. All of the subjects tested were capable of making such distinctions. Figure 68 gives examples of these models from two of the poorest protocols.

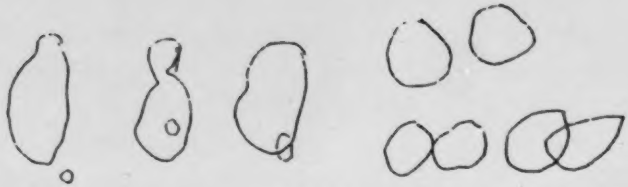


FIGURE 68

Topological distinctions.

Models 20 and 21. Open figures are distinguished from closed ones during Substage IB, but the orientation of the two crosses is not correctly reproduced until Stage II. Figure 69 shows two stages in the discovery of oblique lines. In the drawings on top no distinction is made between the upright and the diagonal crosses. The drawing at the bottom of the figure was begun with a vertical line, and an oblique line was added, showing the emergence of the notion of orientation, but a lack of ability to coordinate all of the relationships involved.

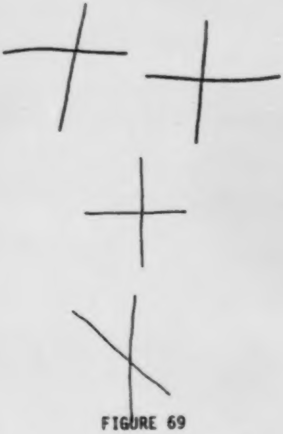
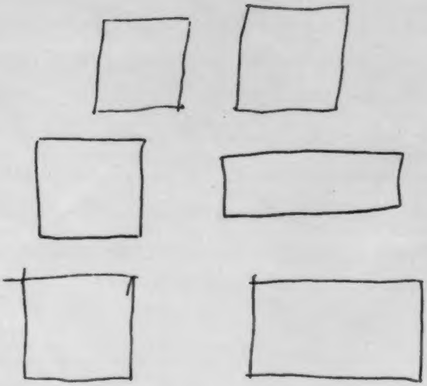


FIGURE 69

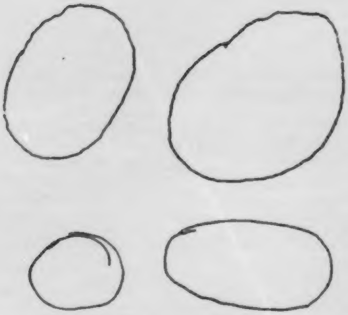
The discovery of oblique lines.

Models 4 and 7, 5 and 8. During Stage II, straight sided figures are distinguished from curved ones, but an understanding of proportion and relative length develops only gradually. Figure 70 shows three stages in the development of proportion. At first no distinction is made between the square and the rectangle. Later the difference is noted but not correctly reproduced. Finally, by the end of Substage IIA proportion is fairly accurately understood. A similar course of development characterizes the distinction between the circle and the ellipse.

Model 6. Drawing a triangle requires the coordination of diagonal lines. During the transition period between Substages IB and IIA straight sided figures are distinguished from curved ones. However, attention is not paid to the number of sides, so that copies of the triangle may have four sides as in the drawings at the top of Figure 71. During Substage IIA more successful attempts at reproducing the triangle are achieved by a trial and error process. Figure 71 shows successive attempts on the part of two respondents to coordinate the inclination of the three lines. They make their initial mistake by beginning their drawings with right angles. In order for the lines to meet at the apex the figure must be completed by a curve or by an extra little line. Finally, during Substage IIB the gradual discovery of acute angles and oblique lines makes it possible to complete the triangle without difficulty.



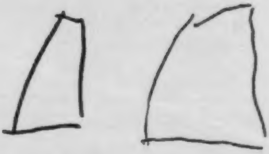
Models 5 and 8



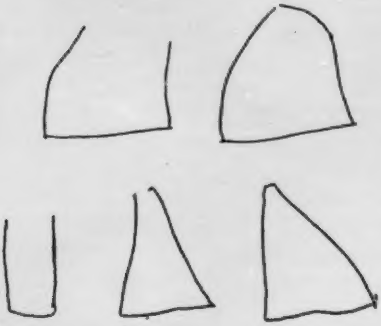
Models 4 and 7

FIGURE 70

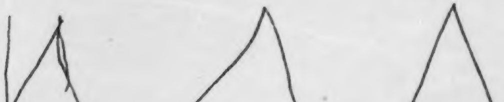
The discovery of proportion.



Four sided triangles



Successive attempts to reproduce a triangle,
Substage IIA



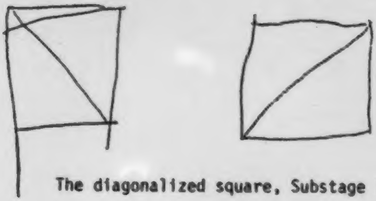
Substage IIB

FIGURE 71

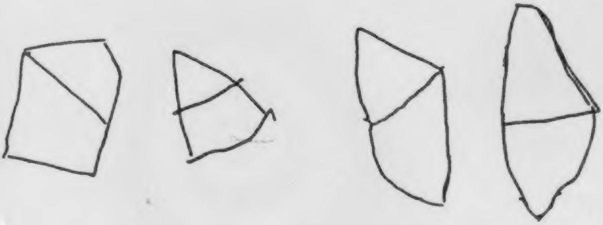
Mastering the triangle.

Models 17 and 19. Substage IIA witnesses the gradual mastery of the square and the rhombus with diagonals. The square is easier to execute, as shown at the top of Figure 72. The diagonalized rhombus is more difficult to reproduce. At the center of Figure 72, the drawings on the left show two unsuccessful attempts by early Substate IIA subjects. The drawings to the right show better understanding. Finally by Substage IIB the diagonalized rhombus is executed fairly well.

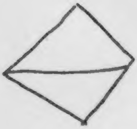
Model 18. The rhombus is one of the more difficult figures to reproduce and is not mastered until the end of Stage II. According to Terman and Binet, the ability to copy a square indicates a mental age of four. Correctly copying the rhombus, however, is not achieved until as late as six or seven. It is not mere skill in drawing, but the abstraction of shape itself that is involved. What is most difficult to achieve is the symmetry between the two triangles that comprise the rhombus shape. In addition to coordinating the angles, the opposite sides must also be paralleled to one another. Figure 73 shows the progressive discrimination of these euclidean relationships. The top of the figure shows examples from the transitional stages between IB and IIA. The failure to execute the figure is total. By Substage IIA, however, some attempts are made to designate the salient features of the shape. The first two figures of the series show two successive attempts by the same subject to draw a rhombus. The lower half of the series shows other attempts during Substage IIA. By Substage IIB the rhombus is almost mastered and finally, in Stage III, the figure is executed without difficulty.



The diagonalized square, Substage IIA



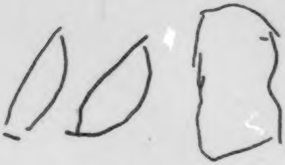
The diagonalized rhombus, early Stage II



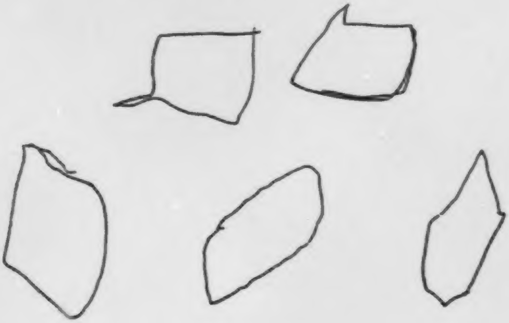
Substage IIB

FIGURE 72

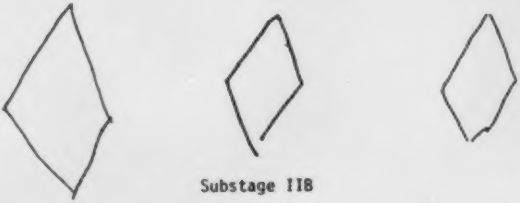
Diagonalized figures.



Unsuccessful attempts to reproduce the rhombus



Substage IIA



Substage IIB

FIGURE 73

The gradual mastery of the rhombus.

Models 12, 13, 14, 15 and 16. Before Stage II the circumscribed figures are little more than closed curves within closed curves (see Figure 74). During Substage IIA the shapes are gradually mastered, but not the points of contact (sec Figure 75). During Substage IIB, the points of contact are more accurately rendered for all of the circumscribed figures save Model 16. This is not done by coordinated anticipation, however, but by trial and error (see Figure 76).

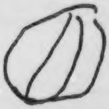
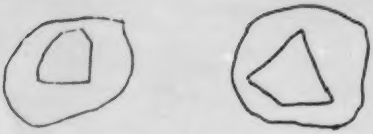


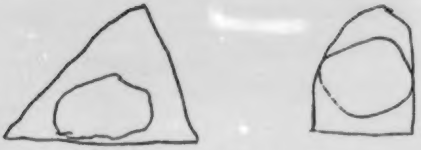
FIGURE 74

A circumscribed figure, Substage IB.

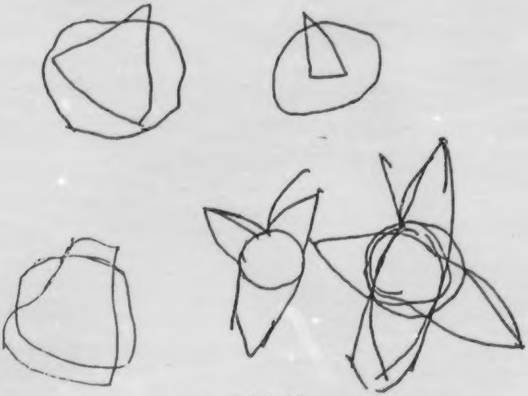
Finally, during Stage III, all of the circumscribed shapes are mastered, no longer by trial and error adjustments, but by operational anticipations (see Figure 77).



Model 12



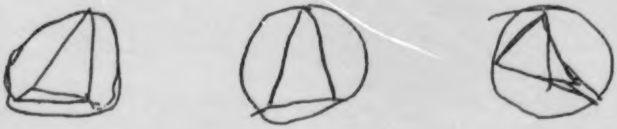
Model 15



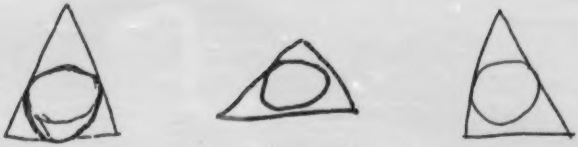
Model 16

FIGURE 75

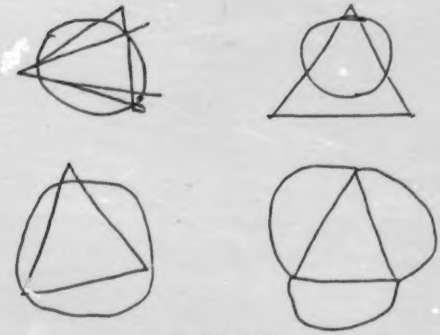
Circumscribed figures, Substage IIA.



Model 12



Model 14



Model 16

FIGURE 76

Circumscribed figures, Stage IIB.

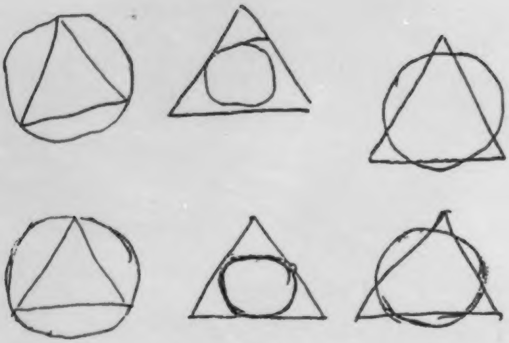


FIGURE 77

Circumscribed figures, Stage III.

Figure 78 shows a complete Substage IB protocol. Notice that the crosses are distinguished from the other figures but no attempt has been made to orient them properly. The triangle and the square are both irregular closed curves with only the faintest hint of angles or straight lines. One of the most successful figures is the diagonalized square, but the diagonalized rhombus as well as the rhombus itself is a complete failure. Likewise the euclidean properties of the circumscribed figures are for the most part ignored, although the topological relationship of enclosure is observed. It can also be seen that the essential features of the topological shapes have all been correctly represented.

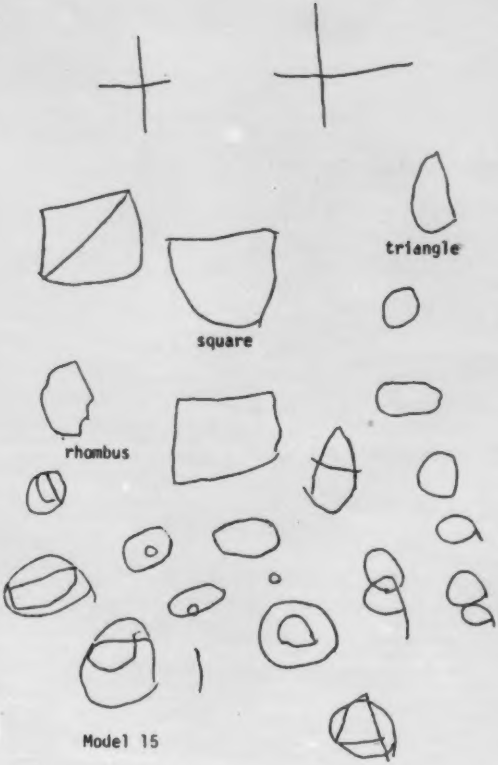

triangle
square
rhombus
Model 15

FIGURE 78

Substage IB protocol.

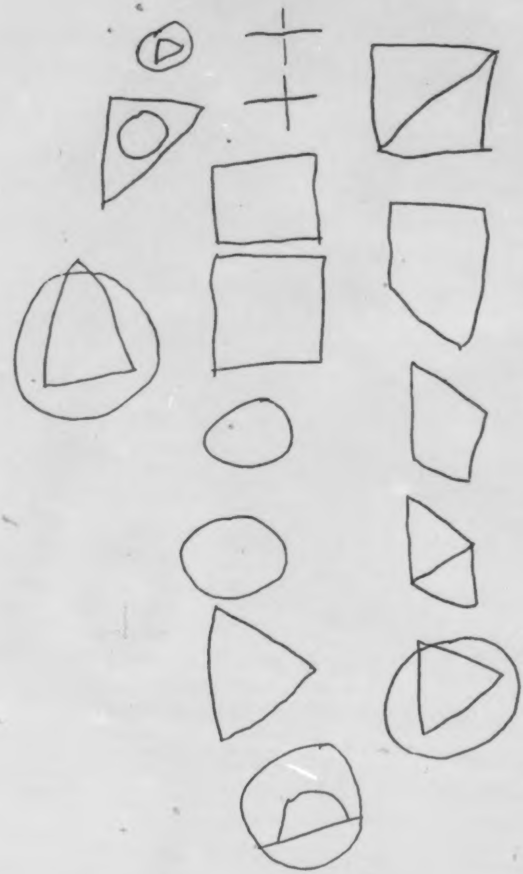


FIGURE 79

Substage IIA protocol.

Figure 79 shows a complete Substage IIA protocol. Many euclidean features such as straight lines and angles have been rendered correctly, but proportion and inclination are still only partially understood. No distinction is made between the upright and the diagonal crosses. The square and the rectangle are drawn alike, as are the circle and the ellipse. The shapes of the circumscribed figures are fairly accurately drawn, but the points of contact are ignored.

By Stage III, most of these problems are overcome. Figure 80 shows a Substage IIIA response. Diagonals and proportion are depicted without difficulty. Two of the circumscribed figures (Models 12 and 15) are not touching at all points, but Model 16 has been properly executed.

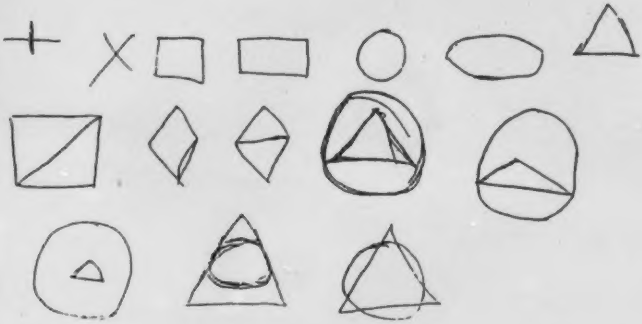


FIGURE 80

Substage IIIA protocol.

Scoring

Responses were judged according to the criteria outlined by Piaget and Inhelder in The Child's Conception of Space. Protocols fell into nine categories. Transitional stages are indicated by +. Therefore a protocol falling into a transitional period between Substages IB and IIA would be marked IB+. Table 15 shows the distribution of the subjects by stage according to their performance on this experiment.

TABLE 15

DRAWING GEOMETRICAL SHAPES:
QUANTITATIVE FINDINGS

Stage	Number
IB and IB+	3
IIA	8
IIA+	2
IIB	10
IIB+	5
IIIA	11
IIIA+	7
IIIB	20
Total	66

As in previous experiments, the sample was divided into subgroups as follows: unschooled illiterate villagers comprise Group I; unschooled but partially literate villagers comprise Group II. Group III consists of primary school attenders and Group IV of secondary school attenders. Group V is made up of the workers at the furniture factory and Group VI of the students at the Institute of Engineering. For purposes of comparing subgroups a numerical value was assigned to each substage with zero being given to any protocol below Stage II and seven being given to Substage IIIB.[1] In this fashion the average performance of each group can be converted into a percentage score, with Substage IIIB equaling 100%. The performances of the six subgroups are plotted in Figure 81.

Thus it can be seen that the illiterate villagers, performing at a level of 38%, averaged between IIA+ and IIB in their overall performance, while the engineering students performed at an average level close to IIIB.

Discussion

According to Piaget and Inhelder it would be a mistake to think that the problems associated with the early stages of drawing geometrical figures stem from a lack of motor ability. The drawings themselves tend to show that this is not the case. Rather the difficulties indicate the regulatory mechanisms that are operative at each stage. Of course all of these subjects could distinguish between a square and a rectangle at the perceptual level. But such perceptions are purely intuitive and are not governed by a coherent system of reversible operations. The abstraction of shape is not simply a matter of perception. It is based on the actions that enable an object to be built up in the mind in terms of its spatial structure. It is interesting to note that performance on this test does not correlate with education nearly so

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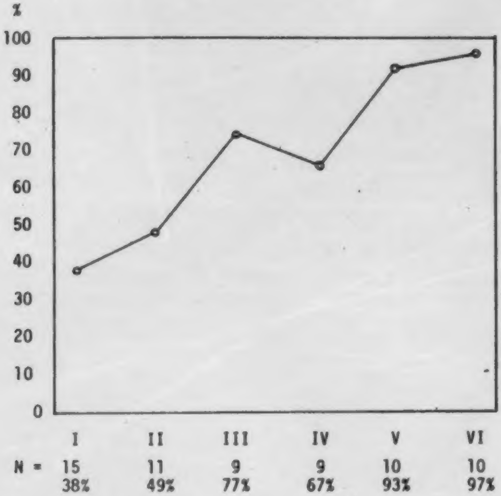
[1] It is perhaps misleading to assign arbitrary numerical scores to discrete stages of development. This has only been done as a way to determine an average level of performance for each of the subsamples and to provide a basis for group comparisons.



I	Unschooled and illiterate
II	Unschooled and partially literate
III	Primary school attenders
IV	Secondary school attenders
V	Furniture factory workers
VI	Engineering students

Substage	Numerical Value	Percent
IB and IB+	0	0
IIA	1	14
IIA+	2	29
IIB	3	43
IIB+	4	57
IIIA	5	71
IIIA+	6	86
IIIB	7	100

FIGURE 81

Copying geometrical shapes: performance by subsample.

closely as the test of counting cubes and making constructions. The primary school sample actually performed better on the average than the secondary school attenders. This is in keeping with Piaget's thesis that the development of spatial understanding comes from experience and activity and not from general education. The superior performance of the furniture factory workers and the engineering students is undoubtedly due to the specific spatial experiences associated with their activities.

Piaget's insights may help us to probe more deeply some of the problems associated with interpreting pictorial material. These experiments demonstrate that spatial concepts involving the abstraction of shape are not fully developed in many of these village subjects. Among the children tested by Piaget and his colleagues in Geneva, Stage II began at about four years of age and Stage III at six and a half or seven. We have discussed in Chapter III, in connection with tests of conservation and equivalence grouping conducted in Africa, that the demands of village life are such that they often do not stimulate some of the higher cognitive processes. These findings seem to apply also to the development of spatial understanding. While perceptual space undoubtedly develops at much the same rate and in the same manner as in every society, representational space apparently does not. We are not concerned here so much with the reasons for such a lack of development as we are with how it affects the interpretation of pictorial material, especially pictures that are designed to be thought about rather than just looked at. One clue offered by this experiment is that pictures which have meaning based on topological relationships are likely to have a higher chance of being correctly interpreted than pictures which have meaning based on projective or euclidean relationships. In our next series of experiments we will examine just such a hypothesis.

Experiment 5: action based on topological cues

Materials and procedure

Subjects were shown a line drawing on an 8 1/2" x 11" sheet of paper depicting a man chopping the limb of a tree (see Figure 82). The subject was asked to identify the various objects in the picture such as the man, the tree, and the sickle. Once the subject had had an opportunity to study the drawing, and if he did not make any spontaneous comment, he was asked, "Is the man doing his work right?" If the respondent said yes or was uncertain, he was asked, "What will happen once he has cut the branch?"

Subjects

Thirty-nine village subjects, two urban women and six workers at the furniture factory performed this experiment.

Results

Out of forty-seven respondents participating in this experiment, three were unable to identify one of the key content items in the picture. In all cases it was understood to be a picture of a man doing something. However, one respondent could not identify the tree. Another saw the tree but not the sickle and thought the man was trying

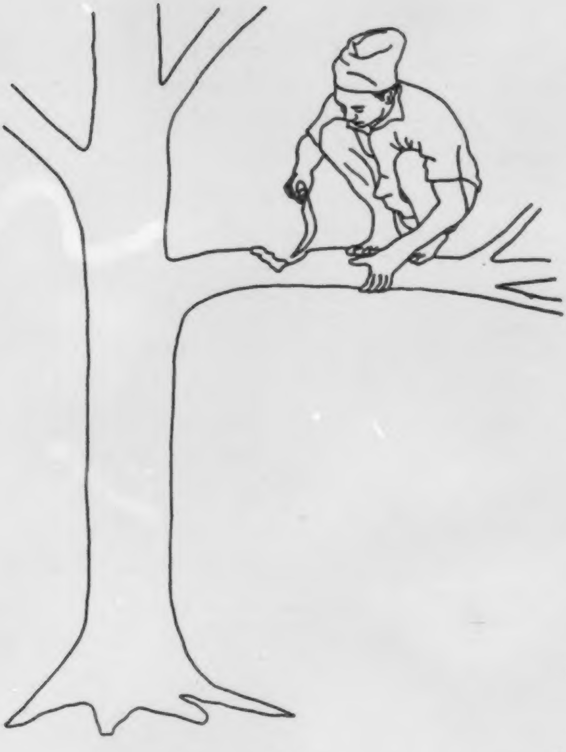


FIGURE 82

Action based on topological cues.

to pick something up. The third respondent said the man was in a house drawing a picture. In fact, that was what the respondent himself had just been doing! Of the remaining forty-four responses, only five failed to interpret the impending results of the action. A number of respondents did not at first see that the man would also fall when the branch was cut. They studied the picture and suddenly burst into laughter with a comment such as "Hopeless man," indicating with a gesture that he would go down with the branch.

Scoring

Of the three subjects who could not identify the contents of the picture, two were illiterate villagers who had weak eyes and one was a partially literate villager who also had scored very poorly (in the 5th percentile) on the test of identifying photographs. These three protocols were eliminated. Of the five who identified the contents of the picture but failed to interpret the action, three were unschooled and illiterate, one was unschooled and partially literate, and the fifth was a literate farmer who had completed tenth grade. On the experiment involving the copying of geometrical shapes, these five respondents scored on the whole rather poorly. One received a score of IB+, three received scores of IIA, and one, the secondary school graduate, a score of IIB. The two urban women and all of the furniture factory workers who were tested understood the action implied in the picture. Overall, the meaning of the picture was correctly interpreted by 89% of those respondents who were able to identify the contents.

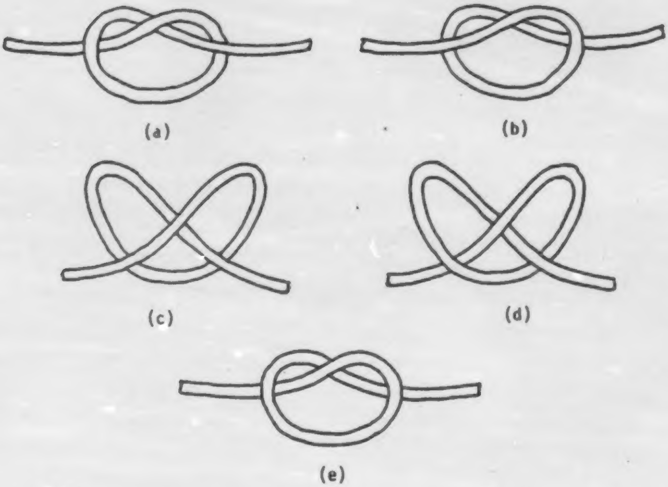
Discussion

The cues in this picture are essentially topological ones--cues of continuity and order. Continuity is represented by the notch in the branch. The interruption in the upper line of the branch was correctly interpreted as a cut. The meaning of the picture depends upon the topological relationship of order--the cut comes between the trunk of the tree and the man. It was hypothesized that meaning which is based on topological cues would be correctly interpreted by these village subjects. So far as this simple exercise goes, the hypothesis seems to be on the right track.

Experiment 6: distinguishing true and false knots

Materials and procedure

Subjects were shown a short piece of twine. The experimenter made an overhand knot and pulled the two ends. "If I pull the string when it's like this, a knot will be formed." The string was untied and formed into a loop. "But if I pull the string when it's like this, there won't be a knot." Subjects were then shown five 3" x 5" cards depicting overhand knots and false knots (see Figure 83). In each case the subject was asked "If you pulled the two ends of this string would a knot be formed or not?"



(a) (b) (c) (d) (e)

FIGURE 83

True and false knots.

Subjects

Forty village adults and two urban women were tested. Of the village subjects, fifteen were unschooled and illiterate and eleven were unschooled and partially illiterate. The remaining subjects were eight primary school attenders and six secondary school attenders.

Results

Out of a total of 210 individual responses only twelve errors were made. Errors were made by ten of the forty-two subjects, nine of them making only one error and the tenth, three errors. Therefore, only one subject scored less than 80% correct on the series of pictures. Picture a was missed twice, picture b once, pictures c and d not at all, and picture e nine times.

Scoring

The ten subjects making errors fell into the four village subsamples as shown in Table 16:

TABLE 16

EDUCATIONAL STATUS OF SUBJECTS MAKING ERRORS IN DISTINGUISHING KNOTS

Status	Number
Unschooled and illiterate (N=15)	5
Unschooled and partially literate (N=11)	3
Primary school attenders (N=8)	1
Secondary school attenders (N=6)	1

The two urban women made no errors. Seventy-six percent of the subjects tested identified all five pictures as knots or false knots correctly.

Discussion

The topological relationship of surrounding is expressed most simply by the location of a point between two others. The cut in the branch of the tree was an example of one-dimensional or linear surrounding. Two-dimensional surrounding is designated by a point falling within a flat surface. Three-dimensional surrounding is defined by space, as in the case of a point within a box. A loop of string forms a two-dimensional surrounding with an exterior and an interior. If one end of the string is passed through the inside of the loop, thereby crossing its interior plane, a third-dimensional surrounding is produced. Topological space is not concerned with angles, distances or straight lines. Topological forms are elastic and capable of deformation, as in the case of the cartoon figures in Experiment 2. Piaget has found that knots are eminently suited for the study of topological space. The perceived pattern must be located in a framework made up of all its potential transformations. The subject must imagine that the process of contracting the knot leaves the relationship of three-dimensional surrounding unchanged. This process is a form of motor activity carried out at the level of representation. All of the subjects tested can undoubtedly tie knots themselves, but imagining the consequences of pulling a string which is viewed as a static two-dimensional pattern involves skills of a very different kind. Piaget and Inhelder write:

> The visual image of a plane figure, a tri-dimensional shape seen in perspective, a projection, a section, a plane rotation, etc., or even the image of an elementary topological shape (a knot, etc.), involves, when it is at all accurate, many more movements on the part of the subject than is generally realized. It is really an image of a potential action relative to these shapes rather than a purely visual intuition.[2]

The evidence of this experiment tends to demonstrate that the relationships involved in three-dimensional topological space, when pictorially depicted, are within the capacity of these subjects to understand.

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[2] Jean Piaget and Barbel Inhelder, The Child's Conception of Space (New York: W.W. Norton and Co., 1967), p. 41.

Experiment 7: arranging a series of pictures in sequence

Materials and procedures

Four 3" x 5" cards, each depicting a woman in various stages of collecting firewood, were spread out all at once in a random pattern in front of the subject (see Figure 84). The subject was asked to describe what he saw in each of the pictures. In some cases the subject was asked whether he thought the pictures showed the same woman or different women. If the answer was "different women" the subject was asked to imagine that it was the same woman in all of the pictures. In all cases the respondents were then asked to put the pictures in order, to say which came first, which second, and so on. Finally, subjects were asked to arrange the pictures in order to actually show the proper sequence.

Subjects

Thirty-nine village subjects and two urban women were tested. Fourteen of the village subjects were unschooled and illiterate, and eleven were unschooled and partially literate. Seven had attended primary school and six had attended secondary school.

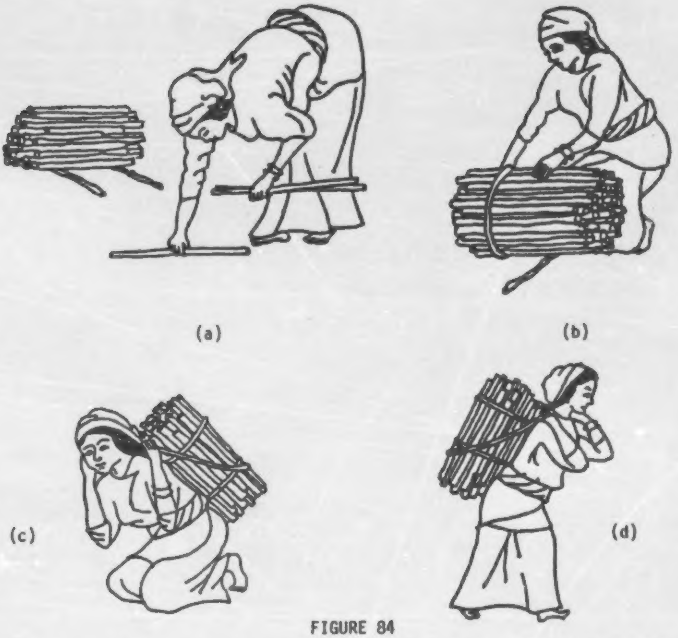


FIGURE 84
A series of pictures depicting various stages of gathering fire wood.

Results

Twenty-five respondents were asked if the pictures showed the same woman or different women. Fourteen said they showed the same woman, eleven said they showed different women. Some of the latter responses were of the type: "Pictures a and b are one woman, pictures c and d are a different woman." All of the respondents were able to identify the action in each of the pictures, but two would not say what order they should be put in. Table 17 shows the responses of the thirty-seven villagers and the two urban women who did designate a sequence for the pictures.

TABLE 17

NUMBER OF SUBJECTS DESIGNATING VARIOUS SEQUENCES FOR STAGES OF GATHERING WOOD

Order of Pictures	Number
a b c d	24
d c b a	8
a b d c	3
other	4

Finally, subjects were asked to arrange the pictures in such a way as to show the order they had designated. Eighteen arranged them in a horizontal row beginning with the first picture at the left. Nine arranged them in a horizontal row beginning with the first picture on the right. Five arranged them in a vertical row with the first picture at the top. Three arranged them in two rows of two, but in no particular sequence. The remaining four made various unique patterns.

One unexpected finding emerged from the arrangement exercise. In all of the pictures save one, the woman is facing left. In picture _d_ she is walking towards the right. Eight respondents, while arranging the pictures in order, turned picture _d_ upside down, whether it came first, second, third or fourth in their sequence. None of the other pictures were treated in this manner.

Scoring

Subjects were scored only on the sequence they designated, not on the pattern or on whether they felt the pictures showed one woman or different women. Three sequences were possible and accepted. The sequence a, b, c, d, which was the original one intended, shows a woman gathering wood, tying it into a bundle, picking it up and carrying it. This interpretation was given by 24 respondents or 61%. Eight respondents (21%) gave the opposite sequence--d, c, b, a. This shows a woman carrying wood, putting the bundle down, untying it, and presumably spreading it out to dry. Though less satisfactory, this interpretation was accepted. Finally three respondents (8%) gave the sequence a, b, d, c. Here the woman was gathering the wood, tying it, carrying it, and finally putting it down. This sequence was also considered a logical interpretation of the events. The remaining four protocols (10%) gave random responses which were considered unacceptable. There are twenty-four possible arrangements of these four pictures. That 90% of the protocols fell into one of the three acceptable patterns shows that these villagers were generally quite capable of arranging pictures in a logical sequence.

Discussion

Putting a series of pictures in order is essentially a topological problem. The particular spatial arrangement of the pictures is not important, as shown by the variety of patterns produced, most of which could conceivably be considered correct. According to Piaget, relationships of order or succession are among the first established in infancy. The sight of a door opening, a figure appearing, and certain movements indicative of a forthcoming meal are sufficient to initiate sucking reflexes. This is an example of a series of actions being perceived as organized in space and time. The sequence of steps involved in gathering wood are similarly organized in space and time. That logical relationships of this sort can be applied by village subjects to pictorial material to create a meaningful sequence is demonstrated by their performance on this experiment.

The fact that almost half of the respondents asked (eleven out of twenty-five) thought that the pictures were of different women poses problems of an entirely different nature. We have seen in Chapter II that posters of the "before and after" type were often misinterpreted by illiterate African factory workers. The situation and dress were so different in the two scenes that the necessary associations were not made. In the sequence in this experiment the woman's dress is the same in all four pictures and she is involved in various stages of the same task, yet she was not recognized as being the same person in a substantial number of instances. To understand that pictures can depict a series of frozen moments in a flowing sequence of action requires an ability to handle transformations. It appears that the difficulties involved in interpreting a series of pictures may have more to do with proper identification than with cognitive problems associated with transformations. The fact that less than half of the subjects arranged the pictures in a left to right sequence (which is also the way the

Nepali language is written) and a significant number arranged them reading from right to left or from top to bottom compounds the difficulty. Another complication was introduced by the change in orientation of the woman in picture d. The fact that eight respondents preferred to position the picture upside down in order to have the woman face the same direction as in the other pictures has important implications for graphic design. Reverse angles may add interest for a sophisticated viewer but merely add confusion for village subjects. All of these latter problems--identification of the same person in more than one picture, reading pictures in the order intended by the artist, and changes in orientation of the depicted object--are pitfalls which may cause communication by means of a series of pictures to break down at some point. However, the difficulty does not appear to lie in the ability of illiterate unschooled villagers to apply the relationship of order to a series of actions.

Euclidean Space

We saw in the preceding section that simple topological notions of space are constructed before euclidean ones. According to Piaget and Inhelder, the concepts of projective and euclidean space develop together and are mutually interdependent. Projective space involves an understanding of perspective resulting from a coordination of various points of view. Euclidean space is concerned with angles, straight lines, distance, parallels, proportion and general coordinate systems. In Chapter II we discussed Deregowski's investigation of pictorial orientation. Zambian subjects were shown photographs of a model

Landrover on a rectangular board and were asked to adjust a similar model until it was "just as shown in the picture." Orientation is a problem of euclidean space and depends upon a well-defined frame of reference.

According to Piaget and Inhelder, the simplest and most natural frame of reference is the horizontal and vertical axes provided by the physical world. This is the first frame of reference we learn. The horizontal axis is given by the plane on which everyday objects rest, such as the ground, the surface of a pond, the floor, or a table. The notion of a vertical axis comes from our observation of trees, posts, walls, and so forth. This natural coordinate system provides us with the cognitive structures needed for such activities as mapping, diagramming, reducing a plan to scale and orienting objects according to a frame of reference. The next experiment examines how well village subjects in Nepal understand these natural axes and are able to interpret empirical facts, such as the constancy of the surface of a liquid whatever the angle of the container.

Experiment 8: frames of reference

Materials and procedure

Subjects were shown a straight sided jar, 5 1/4" high, with a lid, filled approximately one third with liquid tea. The jar was placed on a small portable stand so that it rested at the subject's eye level. The tea in the jar was pointed out to the subject. He was then shown a sheet of paper with full-scale outline figures of the jar at various angles. The sheet of paper was held next to the jar and it was pointed out that the outline and the jar were the same. Pointing to the drawing in the middle of the paper which depicted the jar in an upright position, the experimenter said "This is how the jar looks, isn't that so?" The subject was given a pencil and told to show in the outline drawing where the tea came in the jar. The jar was then put into a small cloth bag and tilted 45° to the right. The subject was shown an outline figure of the jar similarly tilted to the right. If there was any confusion, the sheet of paper was held next to the jar to show the similarity of inclination. The subject was then asked to guess where the tea was in the jar and draw it. If the drawing demonstrated that this particular subject did not understand that the surface of the tea remained constant in spite of changes in the orientation of the container, the jar was taken out of the bag, the subject was shown the actual position of the liquid, and he was asked if his drawing was correct. If he agreed that it was not, he was told to correct it. The jar was again put into the bag and tilted 45° to the left, laid horizontally, tilted 45° to the left upside down and finally placed vertically upside down. In each case the subject was asked to make a new prediction and draw it in the appropriate outline figure.

Subjects

This particular test was part of the pre-test in the Hill Region, so that the findings of both the pre-test and the full experiment can be combined for reporting. A total of 65 village subjects completed this experiment. Seventeen were unschooled and illiterate and seventeen were unschooled and partially literate. Twelve had attended from two to five years of primary school, nineteen had attended secondary school until at least the seventh grade. In addition to the village subjects, two urban women and four workers at the furniture factory also participated in this experiment. The total number of subjects was seventy-one.

Qualitative results

Qualitative results will be described with reference to the stages of development of the concept of horizontality outlined by Piaget and Inhelder in The Child's Conception of Space. As in the case of copying geometrical figures, the understanding of spatial coordinates develops in three stages, with substages and transitional stages. All examples shown are by Nepalese adults.

Stage I begins with scribbles and ends with a topological understanding of the fluid inside the jar. The liquid is not represented as a straight surface but merely as something inside of the jar. Part of the difficulty lies in an inability to isolate the fairly abstract idea of a plane. Such an abstraction is an essential precondition for any possibility of orienting the surface of the liquid. Figure 85 shows a response which indicates a lack of understanding that a liquid surface constitutes a flat plane. The tea is shown as a plane only when the bottle is in a vertical position. In position d in Figure 85 the respondent indicated that the area outlined in the center of the jar was empty. Thus the liquid was partially suspended in mid-air.

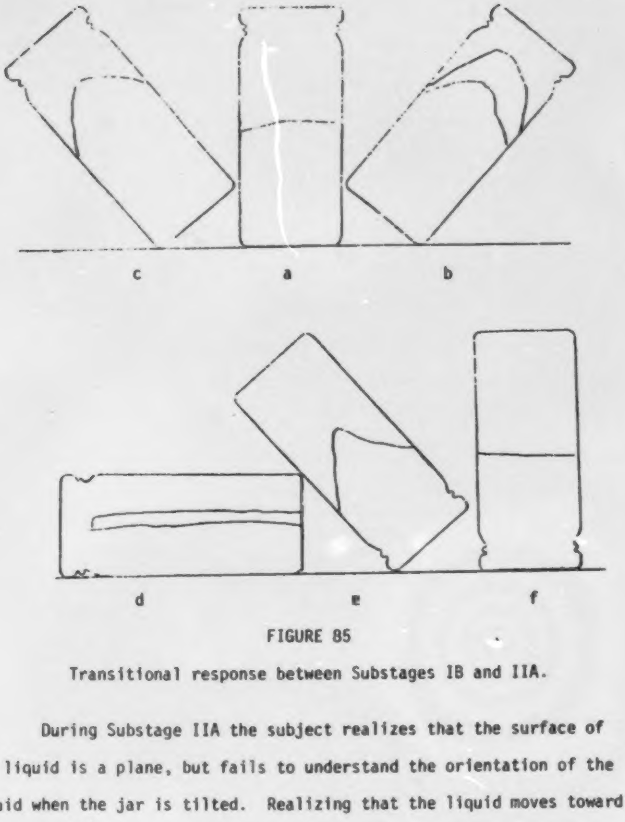


FIGURE 85

Transitional response between Substages IB and IIA.

During Substage IIA the subject realizes that the surface of the liquid is a plane, but fails to understand the orientation of the liquid when the jar is tilted. Realizing that the liquid moves toward the top of the jar, he depicts it as expanding in volume. The surface, in all cases, remains parallel to the base of the jar (see Figure 86).

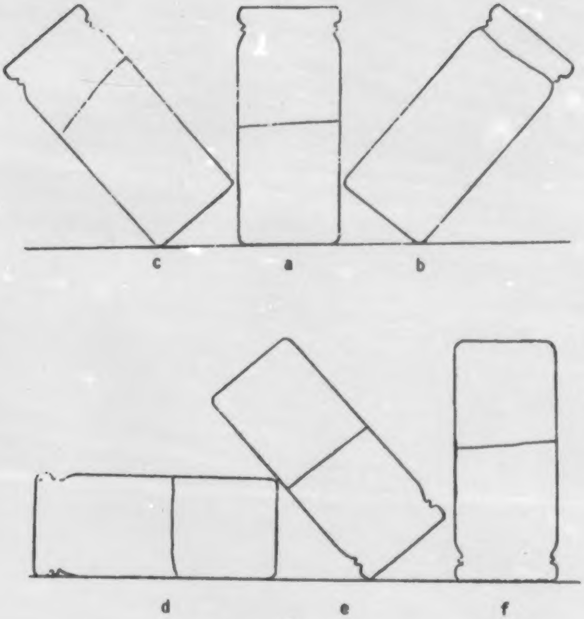


FIGURE 86

Substage IIA.

During Substage IIB the water is no longer always depicted as parallel to the base of the jar. Predictions are still incorrect, however, as the level of the liquid is not coordinated with any system of reference outside of the jar; such as the table. Figure 87 shows a Substage IIB response. It can be seen in position b in Figure 87 that the subject first drew the tea somewhat parallel to the base of the jar

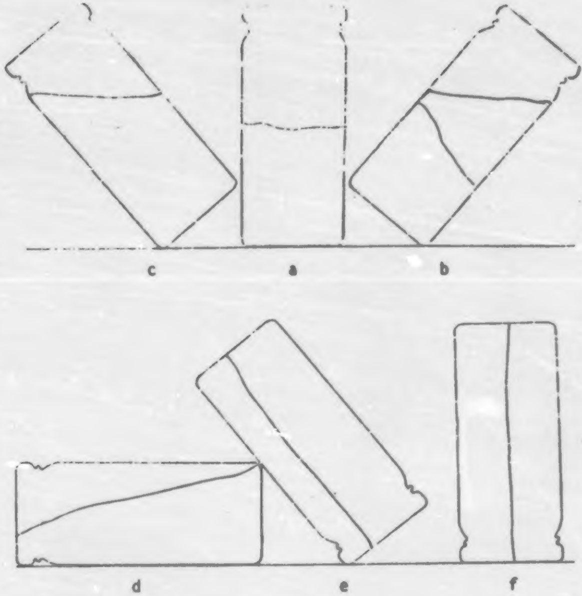


FIGURE 87

Substage IIB.

when it was tilted (oblique line). When he was shown the actual liquid, he was able to correct the orientation (horizontal line). This correction was applied to a similar tilt of the jar to the lef (position c). However, when the jar was laid on its side or inverted, he was unable to apply his correction to the new orientations.

The discovery of horizontality does not come all at once. It develops gradually. Figure 88 shows a transitional response between

Substages IIB and IIIA. The subject initially drew the liquid parallel to the base of the jar (position b) but corrected the orientation when shown. However, when the jar was tilted to the right he failed to apply the information he had just learned. Similarly, when the jar was laid horizontally he drew the liquid as an oblique line. Shown a second time, he again corrected his error (horizontal line). Finally when the jar was inverted at a 45° angle (position e) he was able to

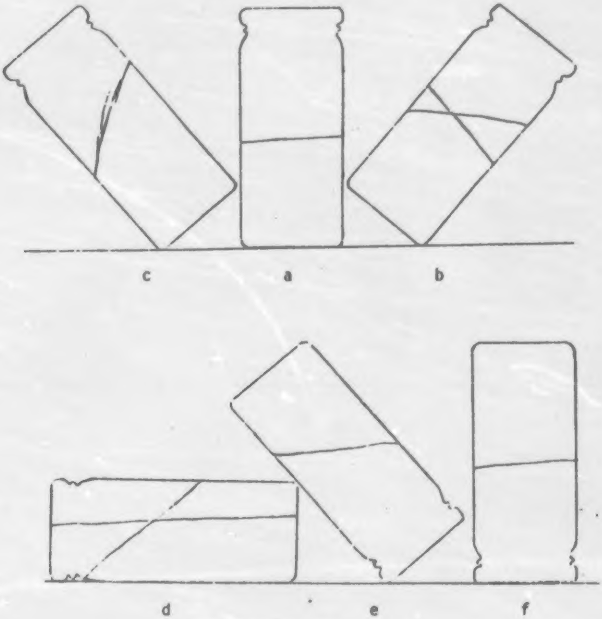


FIGURE 88

Transitional response between Substages IIB and IIIA.

depict the correct orientation. This was clearly a trial and error approach to the solution.

Finally in Stage III the concept of horizontality crystallizes and is applied logically and consistently to all of the situations (see Figure 89).

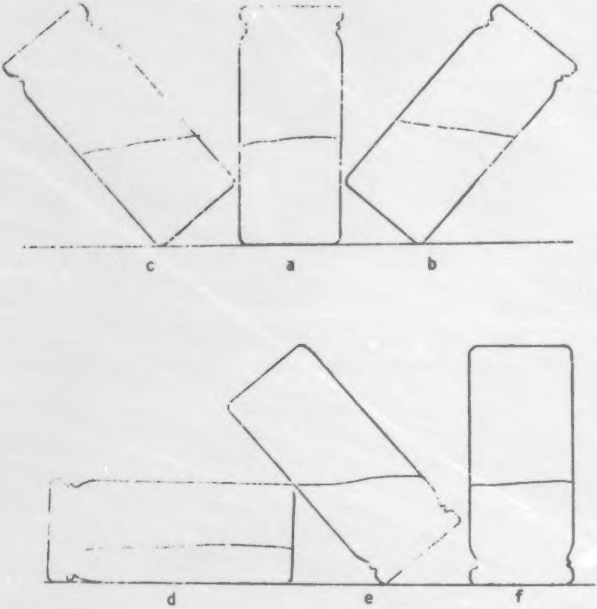


FIGURE 89

Stage III.

Quantitative findings

Table 18 shows the number of respondents performing at each stage.

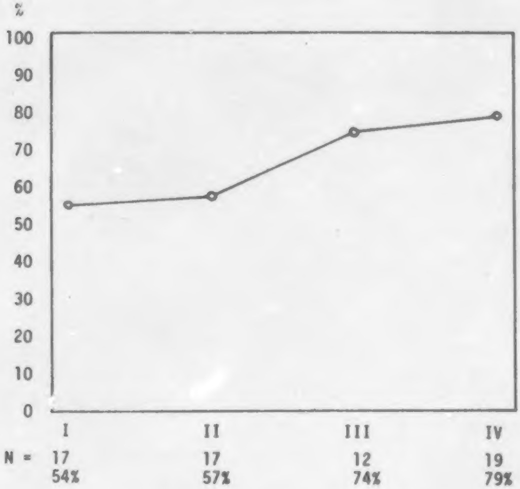
TABLE 18

FRAMES OF REFERENCE: QUANTITATIVE FINDINGS

Stage	Number
IB+	2
IIA	1
IIA+	6
IIB	13
IIB+	9
IIIA	15
IIIA+	10
IIIB	15
Total	71

Figure 90 shows the performance of the sixty-five village subjects divided into four subsamples according to educational status. As in Experiment 4, the substages have been converted into percentage scores in order to determine group averages for the purpose of comparison, with responses below Stage IIA being scored as zero percent and Stage IIIB responses being scored as 100%.

The two urban women, both uneducated and illiterate, gave widely different responses. One was scored at IB+ and the other at IIIB (see Figure 89 for the latter's performance). The four workers at the furniture factory averaged 87%, higher than the secondary school average. This experiment correlates highly with education. Even the primary school group performed dramatically better than the partially



I	Unschooled and illiterate
II	Unschooled and partially literate
III	Primary school attenders
IV	Secondary school attenders

FIGURE 90

Frames of reference: performance by subsample.

literate unschooled group. In fact partial literacy had practically no effect on performance in this exercise. Schooling does not guarantee understanding of coordinate systems, however. Five subjects who had attended secondary school up to the seventh grade or more performed below the Stage II level. Figure 88 shows the response of a seventh grade graduate.

Discussion

The conquest of empty space involves the coordination of objects at a distance from one another. Topological relations are purely internal to each object or pattern. Euclidean concepts, on the other hand, appear much later because they comprise relationships between objects and patterns and entail locating them within an organized whole. Difficulty predicting horizontality may not in itself prove an inability to conceive of a coordinate system; it could be due to lack of interest or of attention. But Piaget and Inhelder point out that the failure to appreciate the material evidence of the experiment carries a much more significant implication. It indicates an inability to evaluate perceptual data in a coordinated manner. By observing the way in which the subject is able to interpret the empirical facts, one is able to analyze the cognitive structures by means of which he records what he perceives.

In the earliest stages of development, the difficulty lies in the inability to abstract planes, similar to the inability to abstract shape in the experiment with drawings. By Stage II the concept of a plane is understood, but its orientation is not yet grasped. During Stage IIA the subjects do not seem to notice that the level of the tea remains horizontal whatever the position of the jar. This shows how poorly commonly perceived events are recorded if the underlying cognitive structures are inadequate for organizing them. The jar is removed from the bag and the subject is asked to correct his drawing while observing the liquid. Yet without a system of reference he is unable to utilize this evidence in subsequent trials. Throughout Stage II the subjects derive hardly any insight from seeing the experiment with their own eyes. Their grasp of the data is so inadequate that they are unable to apply the evidence to succeeding predictions.

At the beginning of Stage III, however, the experimental evidence begins to be understood and is incorporated into the subject's conceptual framework. An experiment is only practical if its salient features can be appreciated and interpreted. Piaget and Inhelder point out that the performance of actions upon an object is not in itself sufficient. These actions must be coordinated. This process of coordination is not part of the physical experiment itself but is rather part of the mechanism of intelligence. The constant orientation of the liquid surface is a concept that cannot be arrived at solely on the basis of experiments. It entails the formation of a rich network of interconnections which leads to the development of a coordinate system. Piaget and Inhelder state that the frame of reference, far from being the starting point of spatial awareness, is in fact the culminating point in the entire psychological development of euclidean space. A framework appropriate for a comprehensive euclidean system is usually not completed until the age of nine, or midway through the period of concrete operations. It should not be surprising, therefore, in light of previous experiments, that out of sixty-five village subjects, thirty, or 46%, were judged to perform at levels below Stage III. It would be expected that these subjects would also have difficulty with representational materials such as maps and diagrams, where euclidean relationships are depicted.

Experiment 9: reproducing a layout

This experiment, which is also described by Piaget and Inhelder in The Child's Conception of Space, involved placing objects in various positions on a model landscape. The experimenter constructed a scene using model houses, trees and animals on a rectangular piece of green cloth which represented an open field traversed by a forked path. Subjects were required to construct a similar village on an identical piece of cloth, a task which involved both topological and euclidean principles. Objects had to be placed relative to one another and to the observer, requiring the simultaneous application of relationships such as proximity, order, distance and angle to a number of items. Subsequently the model landscape was rotated 180° and subjects were asked to reproduce the scene a second time. In this case the subject was also forced to coordinate projective points of view. No longer able to place objects relative to his own position, he was obliged to locate them entirely with reference to the parts of the model.

Fifty-three subjects took part in this experiment. The procedure and results will not be described in detail, however, as the findings merely confirm those of the previous experiment. A substantial majority of the subjects, almost all of whom were villagers, had difficulty reproducing the rotated layout, indicating once again the strong likelihood that depicted layouts in the form of maps or blueprint diagrams would not be accurately understood.

Experiment 10: depicted placement and orientation

Materials and procedure

Subjects were shown a 6" x 4" black and white photograph depicting seven of the same model animals used in Experiment 2 (see Figure 91). They were given eight or nine model animals to select from and a rectangular board and told to arrange the animals "just as in the picture." In addition to the euclidean tasks of relative placement and orientation the experiment involved proper identification of the animals and arranging them in correct order.

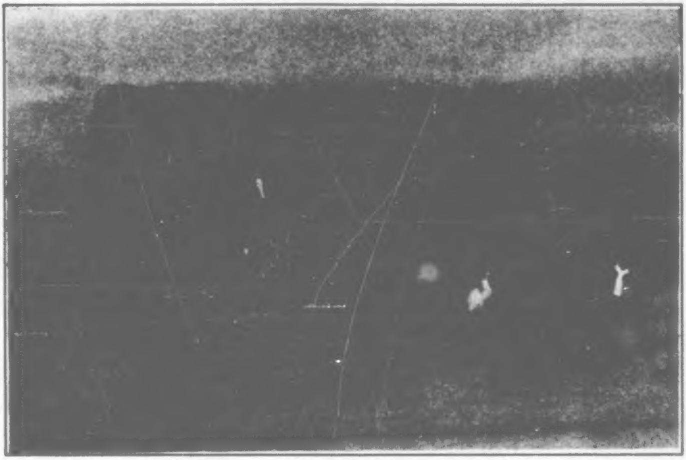


FIGURE 91

Picture used to test understanding of depicted placement and orientation.

Subjects

Twenty-nine village subjects, two urban women, and ten engineering students participated in this experiment. Of the village subjects, fourteen or just about half, had never attended school. Of the schoolgoing villagers, seven had attended three or more years of primary school and eight had attended at least two years of secondary school. The two urban women had not had any formal education.

Results

Out of forty-one respondents all but seven were able to select the appropriate model animals and arrange them in the correct order. Of these seven errors, three involved minor problems of identification: in two cases the horse and the donkey were switched and in one case the two ducks were reversed. A more serious identification error was the substitution of the tiger for the donkey. One subject could not identify the ducks at all. Another left one duck and the sheep out while making his arrangement; finally one subject arranged the animals in exactly reverse order with the elephant leading the pack! Of these seven subjects, one was an urban woman; the remaining six were villagers. Two had attended primary school, the others were all unschooled.

While twenty-three out of twenty-nine villagers were able to correctly identify and order the model animals, only six were able to orient them correctly both with regard to one another and to the picture plane. Of these six all but one had attended school for five or more years. The one unschooled respondent who answered correctly was a bricklayer. It is possible that his work had some bearing on his performance. A schematic diagram of the correct arrangement, which is given in Figure 92, shows that two euclidean relationships must be taken into account. The first is the relationship of the animals to one another. They are following each other in a straight line. The second relationship is the orientation of the entire line to the picture plane, which is at an angle of about 45°. Correct solutions involved arranging the models in a straight line which was oriented obliquely with regard to the edges of the rectangular board.

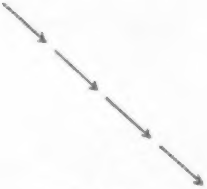


FIGURE 92

Correct arrangement of animals.

One of the most common errors of placement was to arrange the animals in a straight line but parallel to the front edge of the board (see Figure 93). This configuration was produced by eight of the village respondents. It preserves one of the euclidean principles depicted in the photograph, that of the relationship of the animals to each other, but not the oblique orientation of the entire line. The two urban women also gave this response. Another eight village subjects lined the animals up side by side as in Figure 94. This arrangement

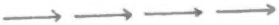


FIGURE 93

Failure to orient line to picture plane.

showed a failure to interpret either of the euclidean relationships correctly. Four respondents arranged the individual animals obliquely, but put them in a line parallel to the edge of the board (see Figure 95). Like the solution in Figure 93, this arrangement depicts one of the relationships correctly, the orientation of the animals to the picture plane but not the other, the relationship of the animals to one another. The remaining three village respondents arranged the animals in the unique configurations shown in Figure 96. All three of these configurations were obviously prompted by the oblique configuration depicted in the photograph but show an inability to reproduce the euclidean relationships correctly.

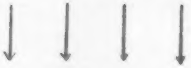


FIGURE 94

Failure to render either relationship correctly.

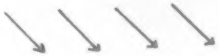


FIGURE 95

Failure to orient animals to each other.

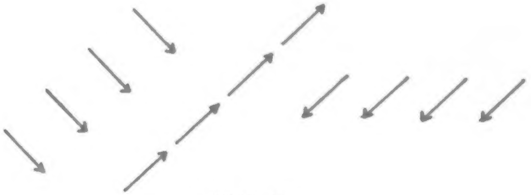


FIGURE 96

Other errors made by villagers.

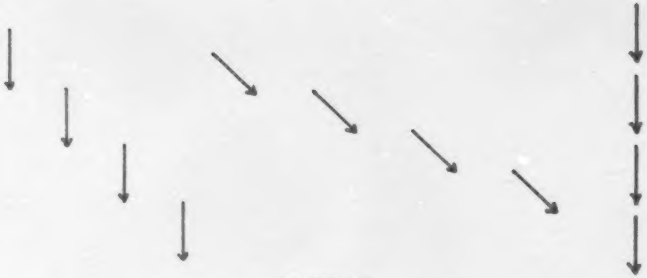


FIGURE 97

Other errors made by engineering students.

The experiment was also given to the ten engineering students. Surprisingly, only five of them were able to produce correct solutions. Two made arrangements as given previously in Figure 94. The remaining three made unique constructions as shown in Figure 97. Again, attempts were made to reproduce the proper euclidean relations but the pictorial space was not completely understood.

Discussion

This experiment demonstrates fairly clearly that topological relationships can be more easily grasped in pictures than can euclidean ones. The experiment does not make clear, however, to what degree the ability to understand depicted euclidean relationships is a function of familiarity with pictorial cues on the one hand or of underlying cognitive structures on the other. Presumably, an inadequate system of reference with regard to real objects would make an understanding of pictorial placement and orientation highly unlikely. A comparison of the results of this experiment with the one involving frames of reference suggests that a system of coordinates is necessary for understanding depicted euclidean relationships, but that it is not in itself sufficient. Familiarity with pictorial material may also play an important role. Of the six village subjects who made correct arrangements, five were rated at various levels of Stage III in the experiment on horizontality, and one was rated at Stage IIB+. However, eleven other village subjects who performed at Stage III on the task of horizontality made errors of various kinds in the present experiment. The experiment gives fairly strong evidence that spatial relationships of a euclidean nature run a high risk of being misinterpreted by village subjects such as these. This places a limitation on the kind of technical or diagrammatic information that can be communicated pictorially. The evidence also suggests that these limitations are largely due to an inadequately developed system of spatial coordinates and only secondarily to lack of familiarity with pictorial cues.

Projective Space

While euclidean space is concerned with the relationship of objects to each other, projective space involved viewpoints and considers objects in relation to these viewpoints. Like the horizontal and vertical axes of euclidean space, however, the development of perspective involves a coordination of viewpoints which links objects and patterns together into a comprehensive system. For this reason, Piaget and Inhelder feel that the comprehension of euclidean and projective space develops simultaneously.

Of course, every optic array is at the same time a particular point of view. The relationships of perspective are, from earliest childhood, familiar to us in the realm of direct perception. However, the child's outlook is entirely egocentric. A perspective system entails being fully conscious of one's own point of view as one of many points of view. The understanding of perspectives furthermore requires the construction of a comprehensive system in which all possible points of view are linked.

According to Piaget and Inhelder, the essential requirement for forming perspectives is the ability to imagine straight lines extending in any direction. The idea of a straight line they point out, is far from elementary, however. It is one thing to be able to recognize a straight line and another to be able to imagine it or construct it. The straight line presupposes projective or euclidean understanding and is not part of topological space at all. The projective straight line is obtained by taking aim and sighting. One can determine, for example, if a row of telephone poles is in a straight line by viewing the row from one end. This is a kind of sectioning operation where nearer objects mask more distant ones. The euclidean straight line is obtained by maintaining a constant direction of travel or by connecting two points by the shortest path. Piaget and Inhelder suggest that the two main relationships that link an object with a point of view are the section produced by the nearer parts masking more distant parts and projection in depth. Projection in depth refers to the phenomenon of receding convergence where objects or parts of objects appear smaller as they become more distant from the point of view. The classic example is a pair of railroad tracks, which are parallel in euclidean space but appear in projective space to merge to a point on the horizon. Piaget and Inhelder write:

> . . . the purely perceptual point of view is always egocentric. This means that it is both unaware of itself and incomplete, distorting reality to the extent that it remains so. As against this, to discover one's own viewpoint is to relate it to other viewpoints, to distinguish it from and coordinate it with them. Now perception is quite unsuited to this task, for to become conscious of one's own viewpoint is really to liberate oneself from it. To do this requires a system of true mental operations, that is, operations which are reversible and capable of being linked together.
>
> It is therefore hardly surprising that perspectives do not become organized in this sense until the middle of Stage III, whereas they are acquired perceptually together with the visual constancies during the first year of the child's existence.[3]

The investigation of projective space has special significance in the study of pictorial communication as all pictures are projections.

Experiment 11: perspective views of a pencil and a coin

Materials and procedure

The present experiment is one that has been used by Piaget and Inhelder to investigate how children represent isolated objects seen in perspective. Asking a subject to imagine how a common object such as a pencil or a coin looks from different positions is to question them about the object's apparent shape rather than its actual shape. Subjects were given a blank sheet of paper and a pencil. They were shown a pencil held horizontally and asked to draw its shape. A Nepalese doll was then placed at right angles off to one side and positioned in such a way that it faced the point of the pencil. The experimenter said, "This is Ram Bahadur. He's looking at the pencil, too, isn't he? From the spot where he is standing, can he see the pencil? Now imagine what the pencil looks like to Ram Bahadur and draw it." Subsequently a coin was shown to the subject and he was asked to draw its shape. Again the doll was placed in a 90° position so that it saw only the edge of the coin. Subjects were asked to imagine how the coin looked to Ram Bahadur and draw it.

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[3] Piaget and Inhelder, The Child's Conception of Space, p. 193.

Subjects

A total of sixty-nine subjects participated in this experiment, including thirteen Hill villagers during the pre-test, thirty-four Terai villagers, two urban women, ten workers in a furniture factory and ten engineering students. Two of the villagers and one of the workers in the factory refused to draw the perspective views, saying they could not do it. The drawings of the remaining subjects were graded according to stages outlined by Piaget and Inhelder in The Child's Conception of Space.

Qualitative results

The discovery of perspective results from discriminating and coordinating different points of view. It requires an understanding that an object is not simply a thing in itself and an awareness of the relations that link the object with the particular viewpoint of the observer. According to Piaget and Inhelder the achievement of such a perspective construction presupposes an operational system. In the case of the pencil, it requires an understanding that a straight line, when tilted away from the observer, remains straight while appearing to become shorter. What is lost in length is gained in depth, a process that leads continuously to the limiting case of a point where the entire length disappears in depth. Similarly, the coin appears as a circle only when viewed head on, and becomes an increasingly thinner ellipse as it is rotated until finally its entire width disappears in depth and only a thin line remains.

Stage I need not be discussed. During Stage II the object is still seen as a thing unto itself, regardless of the angle of observation. In Substage IIA the shape and the size of the pencil and coin are the same, whatever the imagined point of view. Different positions of the pencil

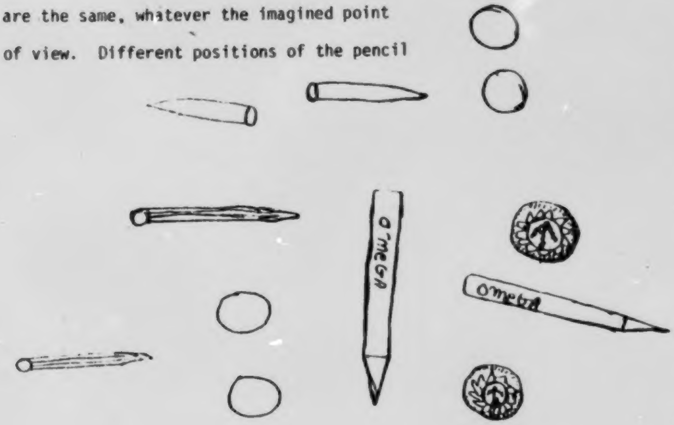


FIGURE 98

Substage IIA responses.

may be indicated simply by different orientations (see Figure 98). It can be seen that drawing ability is not the limiting factor in imagining perspective points of view.

During Substage IIB there is evidence of conscious awareness of a problem. Many of the respondents pondered the task for a long time; finally remarking that Ram Bahadur sees only the point or the front half of the pencil; but they were unable to render this observation in their drawings. It is likely that the three respondents who declined to draw the perspective views were in this substage. During this period the

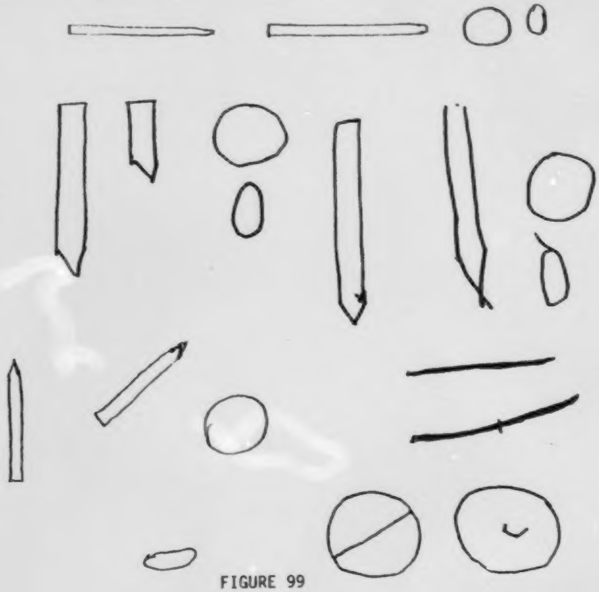


FIGURE 99

Substage IIB responses.

coin seen from the edge is sometimes rendered as an ellipse or a smaller circle (see Figure 99). Notice that one of the respondents drew both the pencil and the coin as shortened. Another respondent drew the perspective view of the pencil just as long as the one seen from the side, but left off the line at the back, saying Ram Bahadur could not see that part. Yet another subject drew both the pencil and the coin full size but drew a line through the perspective views, cutting them in half, presumably to show that Ram Bahadur saw only half as much from his position. It is also interesting to note that even though the pencil was held horizontally, many of these subjects drew it in a vertical position, paying no attention to its orientation.

Between Substage IIB and IIIA there is a transitional period where problems begin to be solved intuitively (see Figure 100). Here the respondent was able to reproduce the coin exactly as the doll would see it, but not the pencil. Notice the twisted perspective of the pencils in which both the side and the back are clearly shown. This is an example of "naive realism" where irreconcilable points of view are joined together. It marks the beginning of an appreciation of

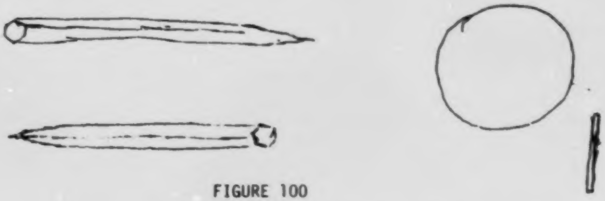


FIGURE 100

Transitional response between Substages IIB and IIIA.

perspective. At this stage, however, perspective is still understood only intuitively and is not governed by laws of transformation.

During Substage IIIA the laws of perspective are gradually discovered. The connection between changes in orientation and changes in perspective are recognized, but the relationships are still not systematic enough to permit solutions to all problems. In Figure 101 we see several examples of Substage IIIA responses. In the uppermost figure the coin has been correctly shown as a thin line, although it

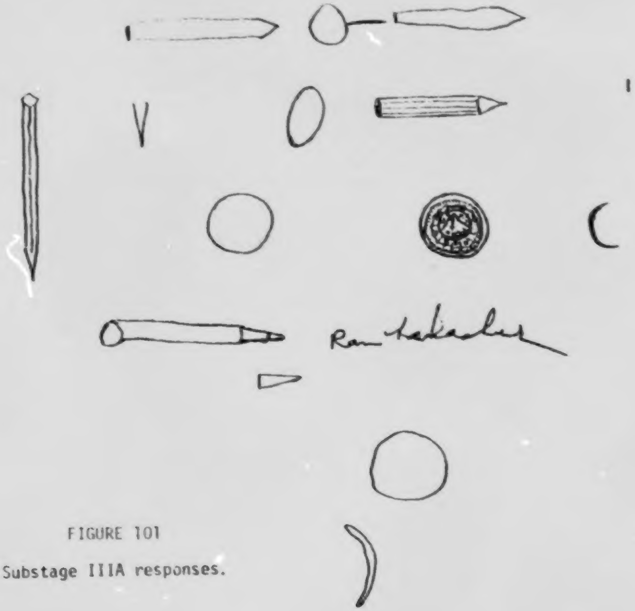


FIGURE 101

Substage IIIA responses.

was drawn horizontally. Notice that an attempt has also been made to show the front end of the pencil in perspective as wider than the back end, but the overall length of the two pencils is the same. In two of the figures the end view of the pencil has been rendered as a triangle. The subjects have noted that the doll would see only the point, but then drew the point as it appeared from their own point of view. In the same manner, two of the protocols show just the edge of the coin, but show it curved as it appeared from their own position.

Substage IIIB is marked by "visual realism" where the laws of perspective are consciously grasped and systematically applied (see Figure 102). The drawing on the top was done by an illiterate villager, the only unschooled subject to have performed at the IIIB level. He was a carpenter. The drawing on the lower left is the work of a village seventh grader and that on the right was done by one of the engineering students.

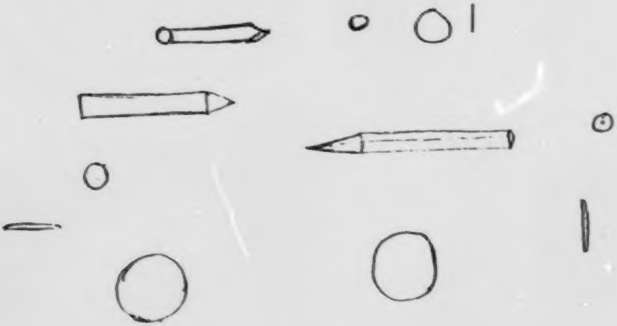


FIGURE 102

Substage IIIB responses.

Quantitative findings

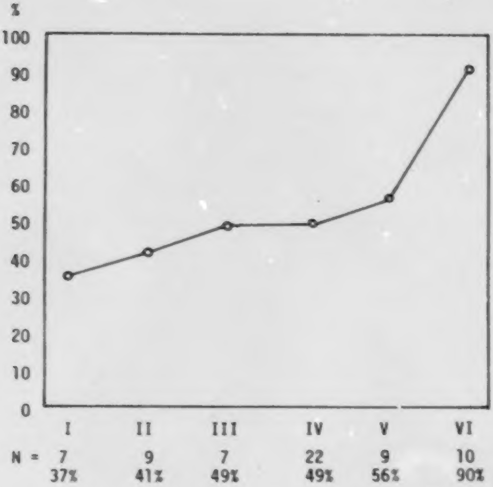
Table 19 shows how the sixty-six complete protocols were rated with regard to Piagetian stages.

TABLE 19

PERSPECTIVE VIEWS OF A PENCIL AND A COIN: QUANTITATIVE FINDINGS

Stage		Number
IIA		16
IIB		13
IIB+		16
IIIA		11
IIIB		10
	Total	66

As in previous experiments, the stages were converted into percentage scores for the purpose of comparing subgroups, with any score in Stage I being assigned a value of 0% and Stage IIIB being assigned a value of 100%. A comparison of the relative performances of subgroups within the sample is shown in Figure 103. The two urban women, who both scored at Substage IIA, are not included in the table, nor are the three subjects who declined to draw the perspective views. The total sample shown in Figure 103 is therefore sixty-four subjects. It can be seen that there is a slight improvement of performance among the village subsamples with education, but that no difference was found between those who had attended secondary school and those who had only attended primary school. The workers in the furniture factory performed slightly better than the educated villagers, showing that the



I	Unschooled and illiterate
II	Unschooled and partially literate
III	Primary school attenders
IV	Secondary school attenders
V	Furniture factory workers
VI	Engineering students

FIGURE 103

Perspective views of a pencil and a coin: performance by subsample.

nature of their work or their urban environment may expose them to experiences that give them a better understanding of perspective. It will be remembered that one of the village carpenters who was unschooled and illiterate performed at level IIIB. He pondered the problem for a long time, however, before drawing the perspective views. The most dramatic improvement in performance is shown by the engineering students. Perspective drawing and sections are part of their course work. This shows fairly clearly that Nepalese villagers are intellectually capable of understanding perspective at a fully operational level, but that they have lacked the specific experiences which would make them consciously aware of the relationships that link an object with a particular point of view.

Discussion

The difficulty in this experiment lies in the difference between perception and representation. To simply see an object in perspective does not necessarily mean that we are aware of our viewpoint. Drawing the object in a given perspective requires conscious awareness of viewpoints and an ability to coordinate them in a coherent system. The Stage II subject is unaware that viewpoints are subjective and attributes to the object a kind of pseudo constancy. This is the reason that so much primitive art lacks perspective and contains the kinds of distortions typical of "naive realism."

Piaget and Inhelder point out that children are able to recognize a correct perspective viewpoint if given a set of pictures well before they are able to draw it themselves. This means that the difficulties in communicating perspective relationships with pictures will not be as great as the difficulties encountered in this experiment. The experiment does show, however, that in the ordinary Nepalese village environment the kinds of experiences that would make a person consciously aware of perspective viewpoints do not generally exist. That it is not a question of innate capacity is shown by the performance of the engineering students who had only recently come from villages themselves. Rather it appears to be a matter of inadequate stimulation. Although drawing might provide certain useful experiences, the failure to adequately render perspective viewpoints was obviously not due to an inability to draw. Some very detailed pictures showed a complete failure to grasp perspective relationships, while some of the simpler drawings done by illiterates showed a much better understanding. We shall see in subsequent experiments that this general lack of awareness does affect the ability of villagers to utilize perspective cues in pictures or to handle those cues purposefully.

Experiment 12: drawing a cube

Materials and procedures

Subjects were shown a 1 1/2" wooden cube, such as those used in Experiment 3, and asked to draw it. During the actual tests this experiment immediately followed Experiment 4, drawing geometrical shapes, and came before the experiments which utilized pictures of cubes. The intent was to determine how subjects would handle the problem of constructing a three-dimensional object on a piece of paper.

Subjects

Thirty-seven villagers, two urban women, ten workers in a furniture factory and ten engineering students participated in the experiment, making a total sample of fifty-nine. Three of the villagers declined to draw the cubes, saying they could not do it.

Results

Of the thirty-four village respondents completing the exercise, twenty-four or 71% simply drew a square (see Figure 104 for an example). Many of the subjects studied the cube for a long time, picked it up, rotated it, and hesitated before producing their drawings. Ten village subjects gave unusual responses that varied from the simple square format. Figure 105 shows a number of these responses. The top two figures were drawn by adults who had never attended school. The next three figures were drawn by subjects who had attended primary school. The drawing on the right, the most successful by any of the village respondents, was done by one of the carpenters. The figures on the bottom row were done by villagers who had attended secondary school. The two drawings on the left show successive attempts by one subject.

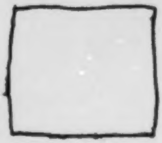


FIGURE 104
Typical drawing of a cube.

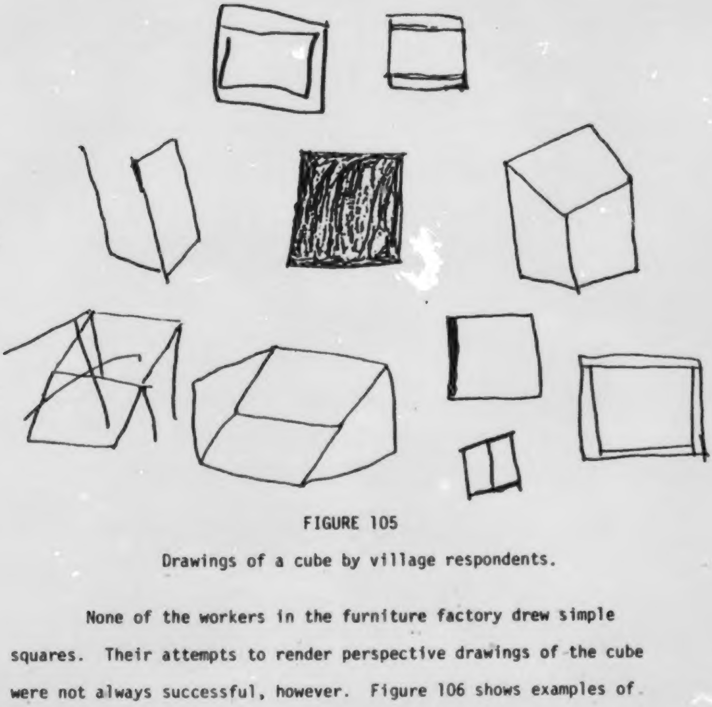


FIGURE 105

Drawings of a cube by village respondents.

None of the workers in the furniture factory drew simple squares. Their attempts to render perspective drawings of the cube were not always successful, however. Figure 106 shows examples of their responses.

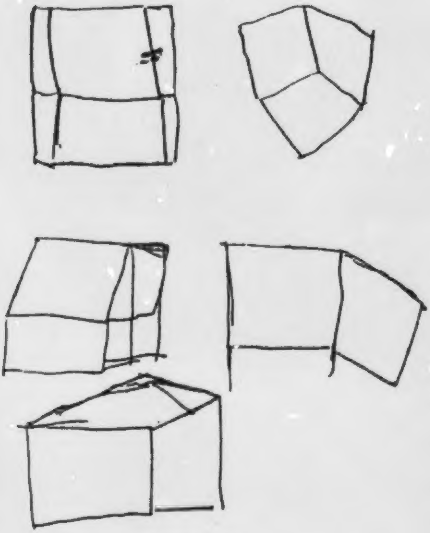


FIGURE 106

Drawings of a cube by workers in a furniture factory.

The engineering students had all studied perspective drawing and this experience was evident in their responses, three of which are shown in Figure 107.

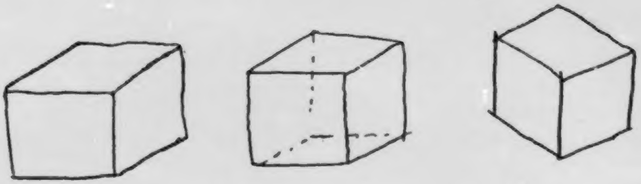


FIGURE 107

Drawings of a cube by engineering students.

Discussion

The school experience seemed to have only minimal influence on the ability of village subjects to draw a three-dimensional object. Of the twenty-four simple squares, eleven were drawn by subjects who had attended school and thirteen were drawn by unschooled respondents. Of the ten unusual village responses, six were made by schooled subjects and four by unschooled. More important than general education seems to be specific experiences. The furniture factory sample showed a generally higher level of awareness that perspective cues could be used to render three-dimensional objects on a flat surface. Their work with blocks of wood and their exposure to drawings of tables, cupboards and other pieces of furniture obviously provided them with experiences that had bearing on this exercise. They were not always able to render the perspective cues correctly, however. Their performance indicates an intuitive understanding of perspective drawing rather than a conscious one. The engineering students, on the other hand, were consciously aware of the principles of perspective drawing and had no difficulty producing satisfactory solutions. The experiment demonstrates fairly conclusively that the construction of perspective relationships in drawings is to a large extent a learned ability. The question remains as to whether the perception of perspective relationships in drawings also must be learned.

Experiment 13: arranging cubes as shown in pictures

Materials and procedure

A 1 1/2" wooden cube was shown to the subject along with Picture 1 (see Figure 108). As there is no specific word in Nepali for cube, the subject was asked, "How many pieces of wood like this one do you see in the picture?" When the answer "Two" was given, a second cube was produced and the two cubes were placed on a rectangular board. The respondent was asked to arrange them "just as in the picture." Each of the remaining pictures in the series was shown, one at a time, with the instruction to arrange the cubes as shown.

Subjects

Thirty-seven village subjects, two urban women, ten workers in a furniture factory and ten engineering students participated in the experiment. One of the village respondents could not say how many cubes were shown, and his protocol was eliminated, making the village subsample thirty-six.

Results

The pictures will be discussed in the order in which they were presented during the experiment. A schematic diagram of the placement of the two cubes is shown with each picture.

Picture 1 (Figure 108) was missed four times. In three cases the respondents left a gap between the two blocks. A fourth subject placed one block on top of the other. All of the errors were made by village respondents.

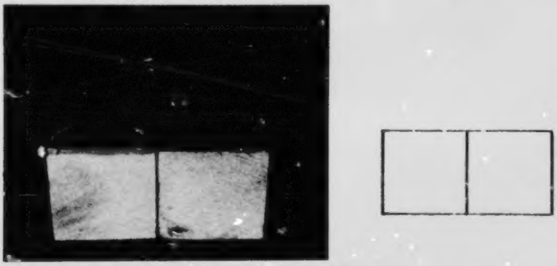


FIGURE 108

Picture 1

Picture 2 (Figure 109) was also missed by four of the villagers as well as by two of the factory workers. Two of the villagers lifted the right hand block up slightly and suspended it in the air. Another villager placed the blocks one on top of another. One of the factory workers made an essentially correct displacement but reversed: the right hand block was forward. The remaining two subjects made arrangements that were no different from those in Picture 1.

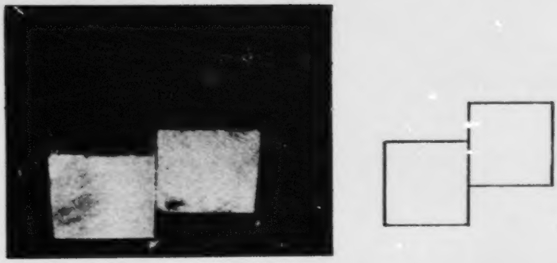


FIGURE 109

Picture 2

Picture 3 (Figure 110) proved to be much more difficult than the previous two, being missed by thirty-two out of thirty-six villagers, by both urban women and by half of the furniture factory workers. Out of a total of thirty-nine errors, thirty-three arrangements were similar to the one shown in Picture 2. The right hand block was moved only half way back. If the picture is viewed as flat rather than in depth, the right hand block appears to be displaced only half of the left hand block. The essential cue, however, is not the front faces, but the top faces, and to correctly interpret these the picture must be seen in depth.

Two other respondents made essentially the same mistake but in addition they lifted the right hand block up and suspended it slightly in the air. The remaining four errors were each unique. None of the engineering students missed this picture.

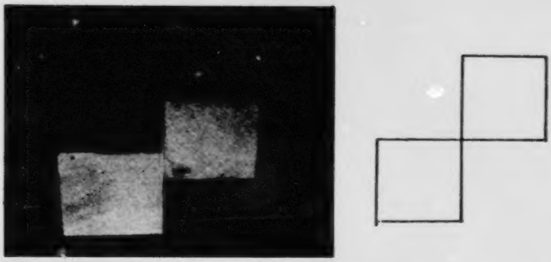


FIGURE 110

Picture 3

Picture 4 (Figure 111) was missed by eight of the villagers and one of the factory workers. Seven of these nine errors were again arrangements similar to Picture 2. In the remaining two cases the respondents suspended the right hand block in the air.

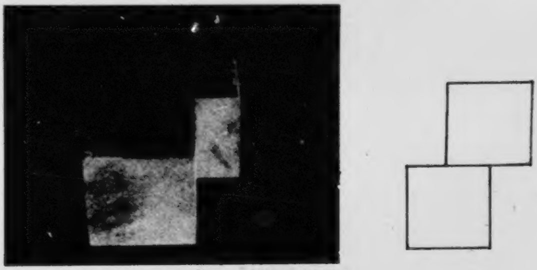


FIGURE 111

Picture 4

Picture 5 (Figure 112) again proved to be a difficult one, being missed by thirty-three villagers, one of the urban women, four factory workers and two of [illegible] engineering students. Out of forty errors, thirty-one arrangements resembled the configuration in Picture 4. The blocks were placed one behind the other, slightly offset, but touching. All but three of these same thirty-one respondents had given correct solutions to Picture 4, but after moving the blocks about, came back to the same arrangement for Picture 5. Five respondents made configurations resembling Picture 2. The remaining four subjects suspended the second block in the air, but touching the first block.

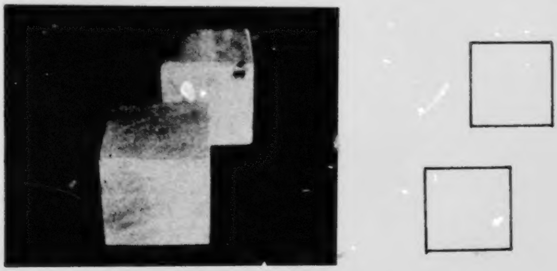


FIGURE 112

Picture 5

Picture 6 (Figure 113) was missed by all of the village subjects but one, by both urban women, by half of the factory workers and by two of the engineering students. The pattern of errors, however, was not nearly so consistent. Twenty of the forty-four errors were constructions similar to Picture 2. Another eighteen respondents made arrangements such as the one shown in Picture 3. In fact many more arrangements of the type shown in Picture 3 were made in response to this picture than were made in response to Picture 3 itself! Four

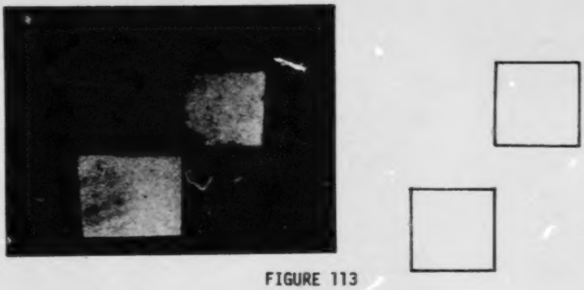


FIGURE 113

Picture 6

responses resembled Picture 4, and the remaining two were made by subjects who touched the two blocks together but suspended one of them in the air.

The performance on Picture 7 (Figure 114) was the worst in the series. Again it was missed by all but one of the villagers, by both urban women, by four of the factory workers and by four of the engineering students. Out of forty-five errors, thirty-one were arrangements similar to Picture 3.

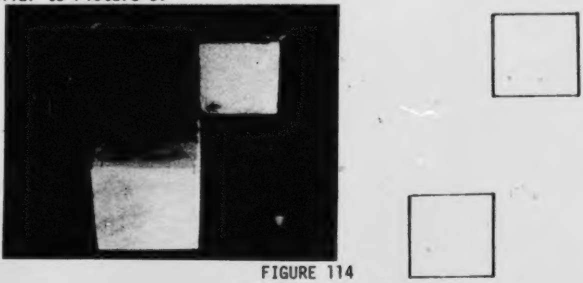


FIGURE 114

Picture 7

Again, the present picture was a great deal more effective in eliciting this response than Picture 3 itself. Three more respondents made arrangements much like Picture 3 but the block behind it was placed obliquely (see Figure 115). Eight respondents suspended one of the blocks in the air and touched the points together. Three of the engineering students made constructions similar to Picture 6. The two blocks were separated, but only slightly.

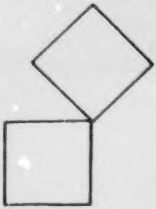


FIGURE 115

An example of an erroneous response to Figure 114.

The percentage of correct interpretations by the three major subgroups for each picture is summarized in Table 20. The column marked Total also includes the two urban women.

TABLE 20

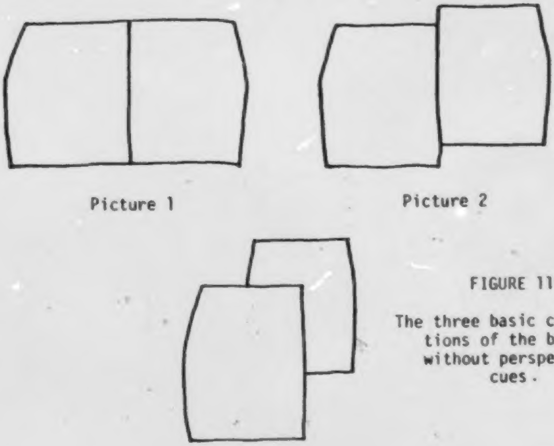
ARRANGING CUBES AS SHOWN IN PICTURES: PERCENTAGE OF CORRECT RESPONSES ON EACH PICTURE BY SUBSAMPLE AND BY TOTAL SAMPLE

Picture No.	Villagers N=36	Furniture Workers N=10	Engineering Students N=10	Total
1	89%	100%	100%	93%
2	89%	80%	100%	90%
3	11%	50%	100%	33%
4	78%	90%	100%	81%
5	8%	60%	80%	31%
6	3%	50%	80%	24%
7	3%	60%	60%	22%

Discussion

All of these pictures were photographs; therefore all of the perspective cues stem directly from the ecology of light. Yet only three of the pictures were generally understood and the remaining four were missed by at least two-thirds of the entire sample and by practically all of the villagers. What accounts for the dramatic difference in performance with regard to these two categories of pictures?

If we look at Pictures 1, 2, and 4, the ones that were generally interpreted correctly and ignore the cues of shading, texture, object size, the convergence of receding parallel horizontals and so forth, but consider rather only the outlines of the two blocks, we find three basic patterns present. They are shown in Figure 116. These basic patterns



Picture 1

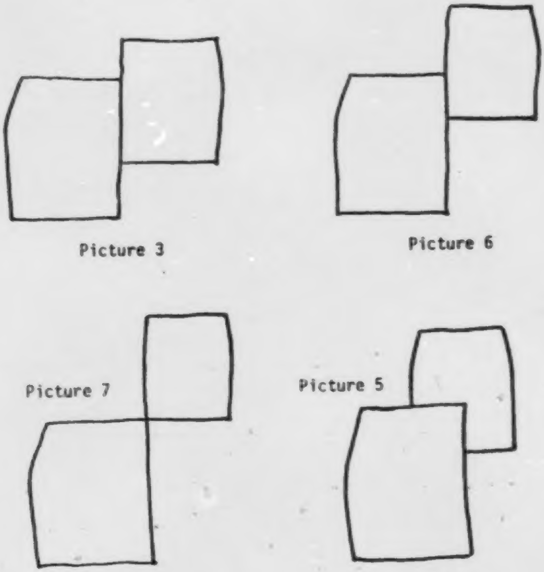
Picture 2

Picture 4

FIGURE 116

The three basic configurations of the blocks without perspective cues.

are topological--side by side, side by side displaced, and before-behind. Now if we consider the group of patterns of the four pictures that were generally misinterpreted, we find they fall into two of these three categories. Figure 117 shows these four pictures in outline form. It can be seen that the fundamental pattern of Picture 5 resembles that of Picture 4 (before-behind) and that the patterns of Pictures 3, 6 and 7 are variations of Picture 2 (side by side displaced).



Picture 3

Picture 6

Picture 7

Picture 5

FIGURE 117

Topological patterns of the two blocks with perspective details removed.

Topologically there is no difference between the overall patterns presented in Picture 4 and Picture 5. If we look at the results of the experiment we find that out of forty errors made on Picture 5, thirty-one respondents (or 78%) made arrangements no different from Picture 4. If we look at the results of Picture 3, we see that out of thirty-nine errors, thirty-three of these (or 85%) were constructions similar to Picture 2. In the case of Picture 6, out of forty-four errors, twenty-one (or 48%) again resembled Picture 2, and another eighteen errors (or 41%) resembled Picture 3. But if Picture 2 and Picture 3 are topologically equivalent, this fairly even distribution of errors should not be surprising and together they account for 89% of the errors made. Finally, out of forty-five errors on Picture 7, thirty-four (76%) were arrangements similar to Picture 3.

These regular patterns of error tend to demonstrate fairly clearly that the pictures were understood topologically and not projectively. Only the engineering students were seen to "take aim" with one eye while arranging the blocks, a type of behavior never observed among the village respondents. This act of aligning the two blocks by sighting showed an understanding that the photograph was taken from a certain angle and that it incorporated a specific point of view. Furthermore, the continuities of surface, especially the tops of the blocks, must be understood to exist in projective space to be properly interpreted. In Picture 3 the tops of the two blocks exist as a continuous plane when seen projectively, but not when seen topologically. Similarly the plane formed by the tops of the blocks is interrupted in Pictures 5 and 6, showing a separation of the two blocks in projective space. Topologically, however, the two blocks appear to be touching.

Certainly part of the difficulty may be attributed to the fact that cubes are not common everyday objects in Nepal. Part of the problem may also be due to a lack of familiarity with perspective cues in two dimensional illustrations, which was certainly evidenced by the previous experiment. But it is interesting to note that even an intuitive understanding of these pictorial cues seems to be lacking in many of these subjects. It will be remembered that in the experiment involving counting and making constructions with cubes (Experiment 3), well over half of the subjects made consistently correct responses to the photographs, but this was not the case in the present experiment. The specific experiences of the engineering students and to a lesser extent of the furniture factory workers seem to have removed some of the difficulties. Perhaps sheer exposure to pictorial material is part of the answer, but it is probably not the entire answer. It is more than likely that conscious awareness of the fact that objects are always seen from a particular point of view and of the perspective relationships that link objects to each other and to the observer also play an important part. We have seen in Experiment 11, perspective views of a pencil and a coin, that such an awareness is generally lacking.

Experiment 14: foreshortening

Materials and procedure

Subjects were shown a line drawing depicting a man from behind about to step up on a box (see Figure 118). This same picture was used

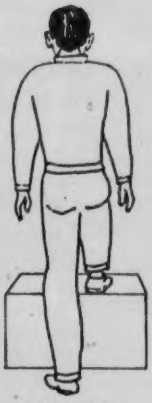


FIGURE 118

Picture used to test understanding of foreshortening. (Adapted from Duncan, Gourlay and Hudson, A Study of Pictorial Perception . . . ," p. 25)

by Duncan, Gourlay and Hudson among Bantu and white children in South Africa. The subject was asked, "What do you see in this picture?" If the answer did not reveal his interpretation of the foreshortened leg, he was further asked, "Why does one leg look short?"

Subjects

Thirty-five villagers and the two urban women were shown the picture.

Results

Out of thirty-seven subjects, twenty-three correctly interpreted the foreshortened leg. Fourteen subjects, however, felt there was a problem. The erroneous explanations are given in Table 21.

TABLE 21

FORESHORTENING: ERRONEOUS RESPONSES TO FIGURE 118

Number of Responses	Explanation
4	leg looks wrong, is not good
4	leg looks small or short
3	leg has been cut
1	leg is broken
1	leg is defective
1	man is diseased
14	

The cue of foreshortening was correctly interpreted 62% of the time.

Discussion

Although this picture was misinterpreted by a substantial number of these respondents, the level of understanding was considerably higher than in the case of the pictures of cubes. The reason for this is undoubtedly due in part to the fact that the subjects were more familiar with people than with cubes. The content of the picture carried some degree of meaning which probably aided in making correct interpretations. Errors may have been due to the kind of thinking characterized as "naive realism" where features are understood topologically rather than projectively. Legs are known to be normally the same length, and as one leg here appears to be short, something must be missing.

This particular picture is fairly schematic and lacking in detail. A photograph might have been more convincing. However, the fact that more than a third of these subjects were confused by this perspective rendering should cause artists to be cautious in using cues of this sort with village people. A side view rather than a back view would undoubtedly communicate the act of climbing more clearly.

Experiment 15: perceiving depth in pictures

Materials and procedure

Hudson's classic study of pictorial depth perception in South Africa was an investigation of projective space depicted on two dimensional surfaces. We have already seen in Chapter II that his test pictures used secondary, monocular cues to illustrate depth--object size, overlap and parallel lines converging towards a horizon. All of these projective cues assume an understanding that the scene is being observed from a particular position and point of view.

We noted in our discussion of Hudson's work and of Mundy-Castle's replication studies in Ghana, that failure to perceive depth in pictures was often accompanied by a misreading of important lines that depicted some of the essential depth cues such as the horizon, the contours of the hills and the edges of the road. Hudson acknowledged that these lines were fairly symbolic and that their meaning might be difficult to interpret. A photograph of models, however, which Hudson considered to be more realistic, was also perceived two-dimensionally by illiterate respondents. On the other hand, school-going samples interpreted the photograph three-dimensionally more readily than they did the outline drawings.

In our preliminary testing in the Hills we used a similar series of outline drawings depicting a shepherd boy with an upraised stick (see Figure 119). In front of him, on the same picture plane, was a goat. Positioned between the boy and the goat, was a water buffalo, shown much smaller than the goat. In addition to this cue of object size, cues of overlap and perspective (converging horizontal lines depicting a road) similar to those in Hudson's pictures were also used. Subjects were asked to identify the major objects in the picture. The boy and the goat were correctly identified in all cases. The buffalo was called a cow by about half of those questioned. The lines showing the contours of hills were understood, but not the lines depicting the horizon or the edges of a road. The horizon was often seen as a road or a river or a piece of string. The road was seen as a mountain. Out of nine subjects shown the series of pictures (seven out of the nine were studying in the seventh grade) only one interpreted the pictures three-dimensionally. These findings substantially confirmed those of Hudson and Mundy-Castle, so the nature of the test was revised for the actual experiment.

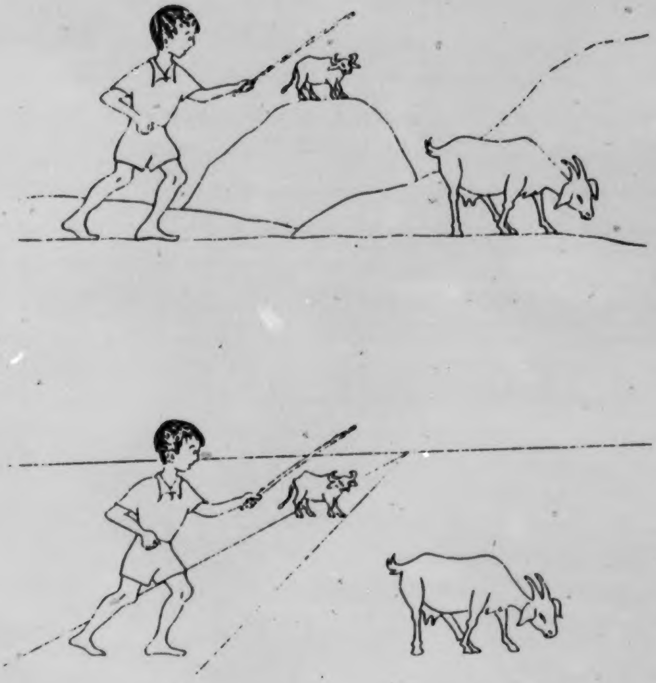


FIGURE 119

Examples from a series of pictures used in preliminary experiments to test cues of depth.

In the present experiment only photographs of models were used. Since roads are not common in Nepal and paths are rarely straight, the cue of converging parallel lines was not included. It was felt that the earlier experiment which involved arranging cubes would adequately test the ability to use this particular perspective cue. The cues of depth were object size, elevation of point of view, and superimposition. Subjects were shown a series of photographs approximately 4" x 8" depicting models of a hunter, an elephant and a tiger. The hunter in each case was a model of a Gurkha soldier by Airfix, the elephant and tiger were by Britains, Ltd. All were 1/32 scale models in realistic colors. Both elephants and tigers are animals known in the Terai region where most of the experimentation was carried out. In all but the first picture the hunter's gun was pointed so that the line of fire crossed the position of both animals.

In the first picture (Figure 120) the three animals are arranged in a straight line, so that the elephant is positioned exactly between the hunter and the tiger. The relative sizes of the three figures are thus shown in their true proportions. In the remaining pictures (Figure 121, 122, and 123) the elephant is placed in the background so the hunter is aiming always at the tiger. Picture 2 uses only the cue of object size. Picture 3 is essentially the same, except the camera position is elevated slightly, causing the elephant to assume a higher position in the picture frame. Picture 2, which views the scene from ground level, is actually quite uncommon in normal perception. A slightly elevated position, such as that shown in Picture 3, allows the viewer to see some of the ground on which the figures are standing. This additional placement cue shows the three models as occupying three points of a triangle seen in greatly foreshortened perspective. Picture 4 uses additional cues of superimposition.

When shown the first picture the respondent was asked to identify the hunter, the gun, the elephant and the tiger. In the case of this picture and all others he was asked "What is the hunter doing?" If the response was not specific enough (e.g., "He's shooting.") the respondent was asked "Is he shooting the elephant or the tiger?" The respondent was also asked "Which is closer to the spot where the hunter is standing, the elephant or the tiger?" Finally he was asked, "Can the tiger see the man?" If the response to a picture indicated that the scene was perceived in depth, the subject was frequently given the actual models and told to arrange them "just as in the picture."

Subjects

All sixty-seven subjects participated in this experim[illegible]cluding forty-five villagers, ten workers in a furniture factory in Kathmandu, ten students at the University's Institute of Engineering and two urban women. Fifty-five members of the sample completed three or four of the test items. The remaining twelve completed, for various reasons, only two. Three of the village protocols were subsequently eliminated because of insufficient data, leaving a total sample of sixty-four.

Results

In Chapter II we mentioned that Leach distinguished between two levels of spatial understanding in pictures: pictorial depth interpretation and pictorial space comprehension. Leach felt that depth interpretation was a much simpler process than space comprehension. The present experiment allows us to examine these two levels of understanding.

Picture 1 (Figure 120). The first picture in the series was used for identifying the depicted objects and for showing them in their relative proportions undistorted by perspective. All of the subjects were able to identify the hunter (some called him a policeman or a soldier), the gun, the elephant, and the tiger. Of the sixty-one subjects who were asked if the hunter was shooting the elephant or the

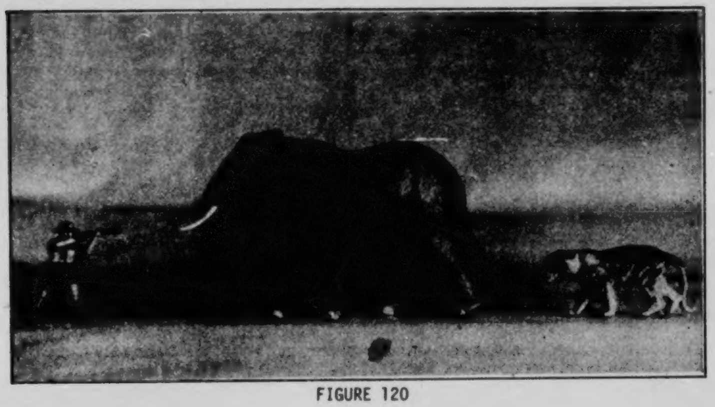


FIGURE 120

Picture 1

tiger, fifty-one said the elephant, nine said the tiger and one could not be sure. The surprising number of respondents who thought the hunter was shooting the tiger is due, undoubtedly, to the fact that, unlike the African elephant, the Indian elephant is often domesticated and used as a beast of burden. Although there are occasionally wild elephants who cause damage and have to be killed, the Nepalese would be much more comfortable with the idea of a tiger being the hunter's prey than an elephant. Furthermore, there is a popular Nepalese household deity, Ganesh, which has the figure of a man but the head of an elephant. One respondent even said that it was a good thing to shoot tigers but not elephants. Another said, "We worship elephants; we shouldn't shoot them."

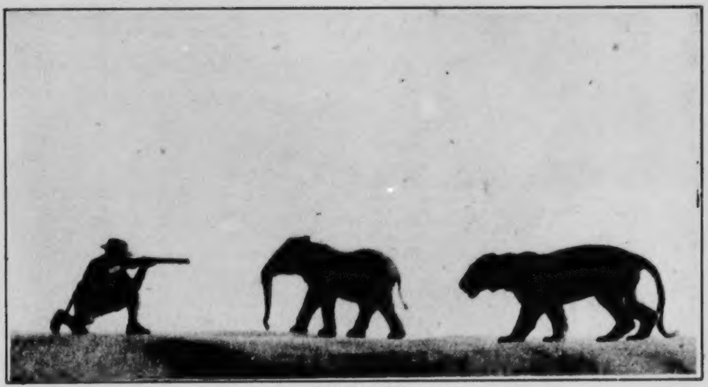


FIGURE 121

Picture 2

Picture 2 (Figure 121). The only cue in this picture is object size. It would seem that this cue would be rendered with maximum effectiveness as this picture was shown right after Picture 1. Depth interpretation was judged according to the answers to the three questions and the arrangements of the model figures. It has been seen that the answer to the first question alone ("Is the hunter shooting the elephant or the tiger?") does not give sufficient information to judge the respondent's understanding of the spatial placement of the figures. He may say the hunter is shooting the tiger for cultural reasons that have nothing to do with the pictorial cues. In fact, five respondents who said the hunter was shooting the tiger went on to explain that the bullet would pass between the elephant's legs on its path to the tiger! Conversely, a reply that the hunter was shooting the elephant could not by itself be interpreted as an indication of two-dimensional perception. It is possible that the gun could be pointed slightly toward the picture background in the direction of the elephant. The answer to the first question had to be confirmed by the answers to the subsequent questions and the arrangement of the models.

Of sixty-three responses to this picture, thirty-three answered that the hunter was shooting the elephant. Out of these thirty-three, eighteen confirmed that they were interpreting the picture two-dimensionally when they said the tiger could not see the man because the elephant was in the way. Another respondent showed clearly a two-dimensional interpretation by arranging the three models in a row. In the case of the remaining fourteen respondents who said the hunter was shooting the elephant it was not possible to say for sure whether the scene was interpreted two-dimensionally or in depth, as they were not asked to produce models.

Twenty-eight respondents said the hunter was shooting the tiger. This apparent depth interpretation was invalidated in ten cases by subjects who either said the tiger could not see the man because the elephant was in the way or who made arrangements showing the three figures in a straight line. In thirteen cases the data was not sufficient to confirm whether the scene was perceived in depth or not. For example, many of those who said the tiger was the prey also said the elephant was closer to the man. The remaining five respondents who said the hunter was shooting the tiger confirmed three-dimensional interpretation with arrangements or by saying the tiger was closer to the man.

Finally, two respondents could not say which animal the man was aiming at. In these cases it could not be determined whether the picture was being interpreted in depth or not.

The sixty-three responses to Picture 2 are shown in Table 22.

TABLE 22

RESPONSES TO FIGURE 121

	No. of Subjects	Percent
Confirmed 2-D interpretations	29	46%
Confirmed 3-D interpretations	5	8%
Uncertain	29	46%

Picture 3 (Figure 122). The third picture, in addition to the cue of object size, contains an additional cue of elevation. By looking

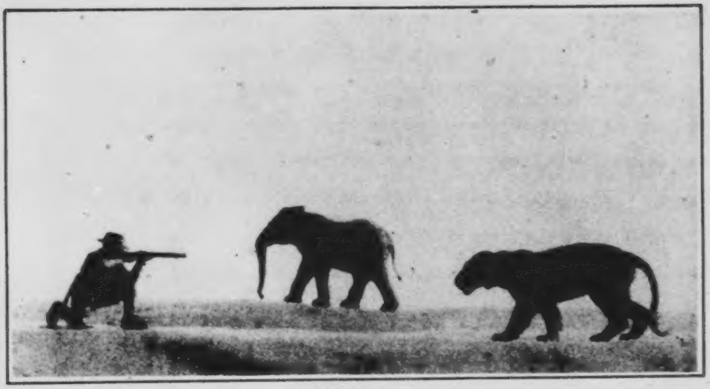


FIGURE 122

Picture 3

down on the scene, even slightly, objects in the background appear to be higher in the picture frame. This perspective cue derives from our everyday experience and is also a common pictorial convention.

Fifty subjects responded to this picture. Of these, thirteen said the hunter was shooting the elephant. Eight of these respondents demonstrated two-dimensional interpretation by saying the tiger could not see the man or by making arrangements showing the three figures in a line. It could not be judged with certainty in the case of four respondents whether perception was two-dimensional or three. One subject who said the man was shooting the elephant also reported that the tiger was closer to the man and could see the man. His response was marked as a three-dimensional interpretation.

Of the thirty-four respondents who said the tiger was the prey, seven demonstrated two-dimensional interpretation of the scene by their linear arrangements of the model figures. Four responses gave insufficient data to determine the type of perception with certainty. In one of these cases the model elephant was placed in the foreground and the man and the tiger behind. But in a full twenty-three instances, depth interpretation was confirmed by the arrangement of the models.

Three respondents could not say at first which animal the hunter was aiming at. But when asked to make models, one demonstrated a two-dimensional interpretation and another a three-dimensional one. The third was not asked to make a model and the data was insufficient to determine his mode of perception.

The fifty responses to Picture 3 are shown in Table 23.

TABLE 23

RESPONSES TO FIGURE 122

	No. of Subjects	Percent
Confirmed 2-D interpretations	16	32%
Confirmed 3-D interpretations	25	50%
Uncertain	9	18%

Picture 4 (Figure 123). In the fourth picture the object size cue is less pronounced. Primary and secondary cues of superimposition are used. The primary cues are the hunter's gun and the tiger's jaw which occlude part of the elephant. The secondary cues are the contours of the landscape which place the elephant on a plane behind the position of either the man or the tiger.

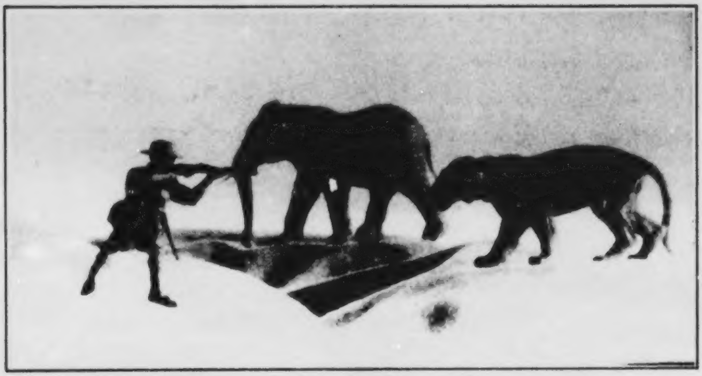


FIGURE 123

Picture 4

Out of thirty-two responses to this picture, six subjects thought the hunter was shooting the elephant. Of these, five were judged to be two-dimensional perceivers either because they said the tiger could not see the man or because of a linear arrangement of the models. In the sixth case the mode of perception was not determined.

Twenty-one respondents said the hunter was aiming at the tiger. Ten of these demonstrated two-dimensional understanding of the scene either by arranging the models in a line with the hunter's gun actually resting on the elephant's tusk or by mentioning that the tiger was biting the elephant's foot. Six demonstrated by their arrangement of the models a three-dimensional interpretation. The remaining five gave inadequate information for determining their mode of perception.

Five subjects could not say which animal was the hunter's quarry, but when making arrangements of the models three of these showed a three-dimensional interpretation. The remaining two were marked as two-dimensional perceivers. In one case the subject made a linear model, and in the other, the subject said the tiger was biting the elephant's foot.

The thirty-two responses to Picture 4 are summarized in Table 24.

TABLE 24

RESPONSES TO FIGURE 123

	No. of Subjects	Percent
Confirmed 2-D interpretations	17	53%
Confirmed 3-D interpretations	9	28%
Uncertain	6	19%

Out of the sixty-four subjects in the entire sample twenty-one (33%) could be considered three dimensional perceivers. These included all respondents who scored at least once in the category "Confirmed 3-D interpretations" with all remaining responses in the category "Uncertain." Twenty-seven subjects (42%) could be classified as two-dimensional perceivers. These respondents scored at least once in the category "Confirmed 2-D interpretations" with the remaining responses being uncertain. The remaining sixteen subjects (25%) gave inconsistent responses--they responded two-dimensionally to at least one of the pictures and three-dimensionally to at least one other. By adding the inconsistent responses to the three-dimensional perceivers, we find that a total of thirty-seven subjects or 58% of the sample gave some understanding that at least one of the pictures depicted a scene in depth.

Analyzing these thirty-seven responses for pictorial space comprehension we find a very different level of competence. Thirty-five of these respondents made models of the scenes they interpreted three-dimensionally. In twenty-nine cases (or 83%) the arrangements were similar to the configuration shown in Figure 124, with the model elephant not more than three inches behind the other two figures. Four of the remaining arrangements differed slightly in their configuration, but the elephant in each case was closer to or equally close to the hunter as the tiger was. Only two subjects made arrangements indicating that the distance between the man and the elephant was greater than the distance between the man and the tiger.

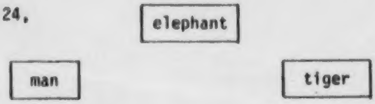


FIGURE 124

Diagram showing the arrangement of the three models made by the majority of the subjects who interpreted the pictures in depth.

In actual fact, in order to produce the perspective view shown in Pictures 2 and 3, the model hunter and tiger would be placed about eight inches apart and the elephant (in order to appear the same size as the tiger) would have to be placed at least four feet behind. Seven subjects, in response to the question "Which is closer to the spot where the hunter is standing?" indicated the tiger, but when producing a model of the scene, they placed the elephant either closer to the man or at a distance equal to that of the tiger. Credit for pictorial space comprehension was given to subjects who indicated that the distance from the hunter to the elephant was greater (even if only to a small extent) than the distance from the hunter to the tiger. Only three subjects were able to meet this standard. Two produced confirming models and the third was not asked to as he said "The elephant is quite small so it must be quite far away." All three of these subjects were engineering students.

Of the twenty-seven respondents who were classified as two-dimensional perceivers, seventeen were unschooled villagers, nine were villagers with some schooling and one was an engineering student. The remaining unschooled villagers (7), the remaining villagers with schooling (10), all ten workers in the furniture factory, eight of the engineering students and both urban women made at least one depth interpretation. Thus all but one of those giving strictly two-dimensional interpretations were village subjects.

Discussion

While thirty-seven subjects (or 58% of the sample) were found capable of interpreting at least one of the pictures in depth, only three subjects (or 5% of the sample) were judged to have in any way accurately understood the spatial relationships among the three models. The experiment confirms Leach's assertion of different levels of spatial understanding in pictures and supports the thesis that depth interpretation precedes pictorial space comprehension and that the two do not occur simultaneously.

The use of photographs in this experiment added cues of shading and texture to those of object size and overlap. Arbitrary lines such as the ones often misunderstood in Hudson's drawings were avoided. It was the experimenter's belief that this format would eliminate many of the abstract elements of outline drawings and present an optic array nearly resembling features of the real world. Another aspect of the present experiment which makes it unlike those carried out by Hudson and others is the inclusion of Picture 1. Here the elephant is shown in its true proportion. During the experiment Picture 1 was put to one side while the subject was studying subsequent pictures. Although the experimenter did not draw the subject's attention to the difference between Picture 1 and the others, the subject was free to look at Picture 1 again if he so wished. Only two respondents actively compared the two pictures while making their judgments. It was also interesting to note that when the models were placed in the configuration shown in Figure 124, the respondents were satisfied with the match between the picture and their arrangements even though the model elephant towered over the other two figures.

In spite of these three important differences between Hudson's experiment and the present one (the use of photographs, the inclusion of Picture 1, and the arrangement of the models), most of the village subjects continued to perceive these pictures two-dimensionally. Examining the performance on Picture 2 it seems clear that the projective cue of object size is understood only at an intuitive level by almost all of these subjects and cannot be applied purposefully in the construction of spatial relationships in pictures. Only 8% of the respondents gave clear depth interpretations to Picture 2 while 46% gave clear two-dimensional readings.

A more powerful depth cue seems to be elevation of the point of view. Fully half of the subjects tested made depth interpretations in response to Picture 3 while only 32% made confirmed two-dimensional interpretations. A number of subjects commented that the elephant appeared to be walking on a different road. One subject even revised his opinion about the previous picture after looking at this one. The triangular pattern of the three figures achieved by a slight elevation of the point of view may have given an intuitive impression of depth. That the degree of depth was not properly understood is shown by the models where the separation of the front two points of the triangle (the hunter and the tiger) from the apex (the elephant) was only slight. The subjects seemed to read the triangular separation literally and not to interpret it projectively, as a greatly foreshortened triangle extending obliquely away from the observer. It was interesting to note that at least ten subjects viewed the pictures from one end as though trying to peer over the hunter's shoulder and studied the scene at length from this angle. Almost all of the subjects who responded to the pictures in this way turned out to be two-dimensional perceivers.

Curiously, the overlap cue, which Hudson found to be the most compelling, did not lead to as many depth interpretations as the elevated point of view. Only nine respondents, or 28% of those shown the picture, demonstrated a three-dimensional understanding of the picture while over half (53%) demonstrated a two-dimensional interpretation. Four subjects thought the tiger was biting the elephant's foot. Eleven respondents arranged the models so that the hunter's gun was actually touching the elephant's tusk. The subtle contours of the landscape seemed to go entirely unnoticed by most of these respondents.

In spite of the large number of uncertain responses in this experiment, it is possible to state fairly confidently that the pictorial cue that led most frequently to depth interpretation was the elevation of the more distant object in the picture frame (Picture 3). Whether this cue was understood projectively, even at an intuitive level, is difficult to say. It might simply have been taken topologically. In Picture 2 there is a direct line connecting the hunter, the elephant and the tiger. In Picture 3, however, it could be said that this continuity is broken or that the line bends into a curve. This may have prompted the arrangements shown in Figure 124 which account for most of the three-dimensional interpretations.

It was also interesting to note that in many cases meaningfulness played a more powerful role in interpreting the action of the picture than did the visual cues. For example, ten subjects who said the hunter was aiming at the tiger in Picture 2 went on to either make linear arrangements of the models (five said the bullet would go between the elephant's legs) or to say the tiger could not see the man because the elephant was in the way. Certainly the response on the part of these two-dimensional perceivers that the hunter was shooting the tiger rather than the elephant was influenced more by cultural values than by their perception of the spatial arrangement of the figures in the picture.

Experiment 16: coordinating perspectives

Materials and procedure

According to Piaget and Inhelder, understanding perspective depends upon operational concepts rather than upon familiarity deriving from intuition or experience. We saw in the experiment which involved drawing a pencil and a coin that only a few of the Nepalese subjects were able to consciously distinguish their own point of view from other possible viewpoints. Whereas the pencil and coin experiment concerned changes in the apparent shape of single objects, the present experiment involves the position of objects relative to one another and to various points of observation. It deals with the relationships of before and behind and left and right but not of above and below. The type of global projective system involved in the present experiment is comparable to the coordinate system needed for the construction of maps and plans in the realm of euclidean geometry.

Subjects were shown a black and white photograph 4" x 6 1/4" of three model figures placed on a rectangular board--a man, a horse and a tiger--depicting a meaningful scene (see Figure 125). The man has a khukri or Gurkha sword in his hand and is facing the tiger while the horse stands to his left. The subject is given three model figures and asked to construct the same scene on a similar rectangular board. Figure 126 shows schematically how the three figures are arranged on the board. Nine additional photographs of the scene were then spread

FIGURE 125

Picture A

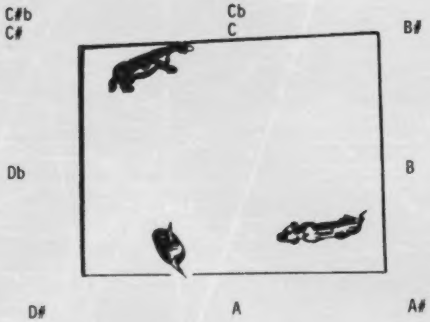

C#b
C#
Cb
C
B#
Db
B
D#
A
A#

FIGURE 126

Schematic arrangement of the models showing positions from which photographs were taken.

out in front of the subject, each showing the same scene taken from a different angle (see Figures 127 through 130). The angles from which each photograph was taken are indicated on the schematic plan shown in Figure 126. It will be noted that three of the pictures, those labeled Cb, C#b, and Db, were printed in reverse, and are therefore false viewpoints showing impossible perspectives.

A Nepalese doll, the same Ram Bahadur used in the pencil and coin experiment, was placed at various positions. The experimenter than said, "Ram Bahadur is standing here. From the spot where he is standing how does this scene look? Can you find it among these pictures?" At times, after a choice was made, whether right or wrong, the experimenter made a counter suggestion, saying, "What about this picture?"

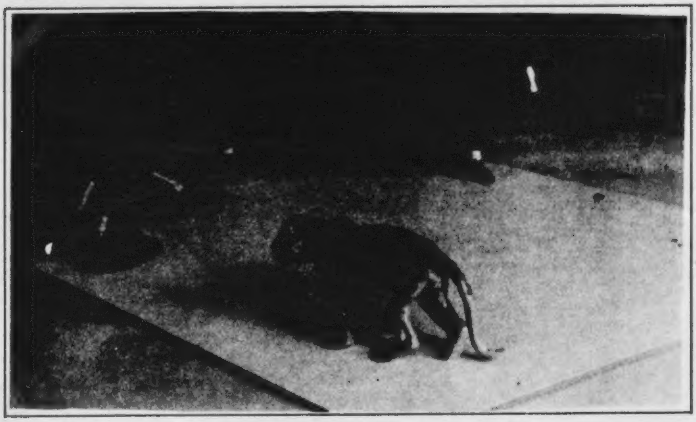


FIGURE 127

Picture A#

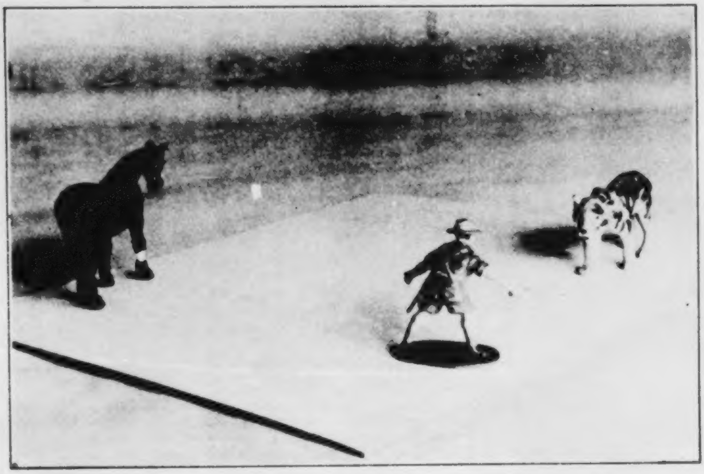


FIGURE 128

Picture D#

Subjects

One of the subgroups that performed well on the pencil and coin experiment was the engineering students. This experiment was given to nine of these students.

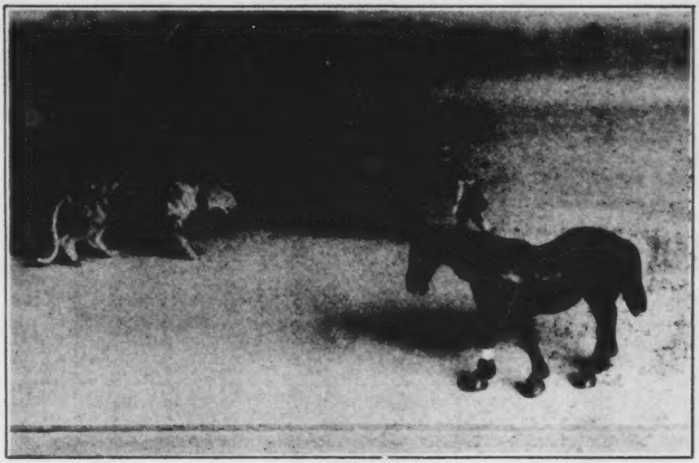


FIGURE 129

Picture C

Results

In terms of qualitative responses, Piaget and Inhelder describe the stages and substages that characterize the gradual mastery of the ability to coordinate perspectives. Throughout Stage II the subject is hardly able to distinguish at all between his own viewpoint and that of the doll's. During Substage IIA the choice of pictures always tend to correspond to the subject's own point of view or else is a random choice which seems to indicate that any point of view will do so long as the three figures are shown. During Substage IIB the subject tries to separate the various points of view by selecting

FIGURE 130

Picture Cb: an example of an impossible perspective.

certain prominent features (such as "Ram Bahadur is standing in front of the horse now.") but is unable to coordinate the left-right and before-behind relationships. The choice of picture is based essentially on the topological principle of proximity. Piaget calls these first transitional efforts "pre-concepts," as the relationships are not "grouped" within a system of reciprocal transformations. A true concept implies its coordination with other concepts. At Substage IIB the left-right and before-behind relationships are still intrinsic properties of the scene and not related to a point of view.

The progressive discrimination and coordination of perspectives is achieved during Stage III. During Substage IIIA the various relationships are considered in a piecemeal fashion, one after another. By Substage IIIB the subject already has in his mind an anticipatory framework of all the possible points of view. The ability to coordinate all possible points of view gives an overall unity to projective space.

Table 25 shows the pictures selected by the nine engineering students for various positions of the doll. The students have been listed in order of the quality of their performance, beginning with the poorest. The Piagetian stage has also been noted based on each set of responses.

Discussion

None of the engineering students were able to find the correct solution for all of the positions. Even the three best subjects (rated at Stage IIIB) made errors, although the errors were not serious ones. For position D there was no picture, and a correct answer would have indicated this fact. The two best respondents apparently did not consider this possibility and settled for the closest solution (D#). The two students who performed most poorly consistently selected views that were only slight variations of the scene as it appeared to them. The transitional student (IIB+) tried to select views based on certain striking features of the layout, but was unable to coordinate the left-right relationships. It is interesting that these same three students (Numbers 1, 2 and 3) who performed in Stage II in the present experiment executed the perspective drawings of the pencil and the coin

TABLE 25

PERFORMANCE OF NINE ENGINEERING STUDENTS ON TEST OF COORDINATING PERSPECTIVES

Student	Position of Doll						Piagetian Stage
	C	B#	A#	C#	B	D	
1	D#	A		A			IIA
2	A	D#	D#	0	D#		IIB
3	Cb*	0		Db			IIB+
4	Cb**	B	A	0+			IIIA
5	0	B		C#b**			IIIA
6	0	A#		0+			IIIA
7	C#	0	0	0			IIIB
8	0	0	A	0		D#	IIIB
9	0	0	0	0+		D#	IIIB

Key:	0	Correct response
	*	This student was shown picture C but felt Cb was a better choice
	**	Choice was corrected after student was asked if he was certain
	+	Resisted a counter suggestion

fairly easily and were rated as Stage III. There are two possible factors that may account for this. The first is that these students had practiced drawing perspective views of solid objects as part of their coursework, but probably had not been required to coordinate the position of objects relative to one another from various points of view. A training factor could account for the superior performance in the earlier experiment. Piaget, however, tends to discount training in the acquisition of operational concepts. He noted that the ability to coordinate perspectives usually develops about a year later than the ability to imagine perspective views of isolated objects. Even though all of these students are adults the same sequence of difficulty may account for the relatively poor performance of some of the engineering students on this task. Even one of the students rated at IIIA (#6), for each position of the doll, consistently selected Picture A (his own view) and studied it for a long time before rejecting it.

According to Piaget and Inhelder, a "point of view" cannot exist in isolation, but necessarily involves the construction of a complete system linking all points of view, just as in euclidean space matric relationships are linked in a coordinate system. This, they assert, is the fundamental difference between projective and euclidean space on the one hand and topological space on the other. The mental operations required to integrate perceptual data are quite different for these two kinds of space. Topological understanding consists of assembling perceptual data into a coherent group, linking the parts of the object together by a process of "adding" proximities and separations, and forming ordered series and enclosures. Understanding projective space, on the other hand, consists of coordinating perceptual data in terms of reciprocal relationships, linking together all the projections of an object or a group of objects through a process of "multiplying" these relationships. The problem in the present experiment is not one of mere topological proximity. It is a projective problem precisely because no one visual picture corresponding to a particular point of view can render the spatial character of the whole. According to Piaget, projective relationships can only be grasped through an act of intelligence which links a particular perspective with the universe of possible perspectives. For this reason perspective understanding is conceptual in character rather than perceptual.

The engineering students performed generally at a high level on most of the experiments in which they participated. The coordination of perspectives was the most difficult of the Piagetian tests and for that reason it was not given to the village sample. The fact that a third of these students performed at the Stage II level and more than half of them had difficulty imagining this simple scene from different points of view indicates that even two years of study in a field as directly concerned with perspective relationships as engineering has not given these subjects fully operational mastery of projective space. This is in keeping with Piaget's assertion that operational ability cannot be directly taught but derives from motor activity and manipulative experience over a long period of time. It is evident that the difficulties experienced by these students in understanding the spatial relationships portrayed in these photographs are conceptual and not a question of lack of familiarity with the photographic medium or pictorial conventions.

CHAPTER VI

SUMMARY AND CONCLUSIONS

The series of sixteen tests described in Chapters IV and V dealt with three basic questions. The first question had to do with pictorial recognition. To what extent do pictures provide the same optic information as the real world of objects? Is the recognition of pictures largely a gift allowed us by the environment, as Kennedy claims? Or are they so ambiguous that it is "surprising . . . we make anything of them at all," as Gregory puts it? Keeping this first question in mind, all of the test items used pictorial cues that derive from what Kennedy describes as the "ecology" of light. Arbitrary conventions, such as lines of motion, cut-away views, diagrams, stick figures and so forth were avoided. The second question derived from recent cross-cultural research in cognition. It has been found that traditional societies often fail to provide adequate intellectual stimulation for the development of some of the higher cognitive processes. We wanted to find out if this was true in the case of our Nepali subjects, and particularly, we sought to investigate difficulties pertaining to spatial tasks. Berry, among others, has mentioned that spatial ability is often singled out as "the psychological underpinnings of technological development."[1] For this reason we selected several tests of spatial understanding from Piaget and Inhelder's The Child's Conception of Space. The third question we raised had to do with whether or not any of the spatial difficulties the subjects encountered with real objects would have bearing on their understanding of pictorial space. A number of studies reviewed in Chapter II demonstrated that unacculturated villagers do not readily perceive depth in pictures and are not able to use pictures as blueprints for construction tasks. Are these difficulties primarily due to lack of familiarity with pictorial material or are they in some way a function of an inadequate understanding of spatial relationships in general? In this chapter we shall briefly review our findings with regard to each of these three questions and make recommendations for the design of pictorial materials.

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[1] J.W. Berry, "Ecological and Cultural Factors in Spatial Perceptual Development," p. 140.

Picture Recognition

The first experiment, identifying photographs, was primarily intended to establish the level of ability among the sample with regard to recognizing pictured objects. It will be remembered that Herskovits reported the incident of a Bush Negro woman who was unable to identify a picture of her own son. Were this the case in the present situation, the investigation of subtle cues of perspective and orientation would be futile. As it turned out, the sample performed surprisingly well on this experiment. Their overall rate of accurate identification of photographs was 85%. In a much more extensive survey of pictorial recognition in Nepal, Fussell and Haaland found that photographs were correctly identified only 59% of the time and that their most successful pictorial format, the three-tone drawing was recognized only at a level of 72%.[2] The pictures in Experiment 1 were generally more difficult than those used by Fussell and Haaland. Therefore it can be stated fairly confidently that the sample used in the present set of experiments is on the whole better at picture recognition than the average group of Nepalese villagers. It can also be assumed that whatever difficulties are encountered by the present sample, similar difficulties would likely be found among villagers throughout the country. Many of the photographs in Experiment 1 were taken from unusual angles or contained confusing background information. Nevertheless, the experiment tended to confirm the findings of Hochberg and Brooks who felt that pictorial recognition of familiar objects is largely an ability that does not require specific training.

In Experiment 2, where photographs, line drawings and cartoons had to be matched with model animals, it was found that there was little difference in the rate of recognition for each of these styles. The success of the cartoons came as something of a surprise. Cartoons exaggerate features by stretching and bending. Proportion, however, is a quality of euclidean space, and the distortions present in these cartoons preserved the essential topological relationships of order, proximity, separation and enclosure. The lack of realism in the cartoon figures did not seem to stand in the way of their identification. This fact lends support to Kennedy's thesis that the recognition of pictures is a simple matter of passive registration.

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[2] Fussell and Haaland, Communicating with Pictures in Nepal, p. 18.

The test using pictures of cubes for simple constructions (Experiment 3) and the one on foreshortening (Experiment 14) revealed, however, that not all pictures are understood with equal facility. In Experiment 3 a great many of the subjects counted the faces of the cubes in the pictures, failing to correctly interpret the cues of perspective. For example, thirteen respondents identified the line drawing of one block as three blocks. The drawing is divided into three sections showing three visible faces. However, none of the faces are square, and three cubes could not possibly be fit together in the manner shown in the picture. This means that the euclidean properties of the cube--equal lengths and right angles--were not taken into account when interpreting the picture. The picture appears to have been understood topologically, and the fact that the blocks would have had to have been bent out of shape and squeezed together in order to fit into the three sections of the picture was apparently of no concern. Similarly, in the case of the picture of a man stepping on a box, over a third of the respondents felt something was wrong with the foreshortened leg. It will also be remembered that among the photographs in Experiment 1, the perspective view of a plate was one of those most frequently misinterpreted. Only 62% of the subjects were able to identify this common object.

Leaving aside the question of pictorial space as it pertains to the relationship among several objects, let us consider the question of perspective as it applies to various views of a single object. It appears that the difficulty in all of these instances is an inability to interpret perspective cues. In the case of the man and the plate, the more distant parts of the object are partially masked by nearer parts. Thus the man's upper leg cannot be seen and a portion of the diameter of the plate is lost in depth, making it appear elliptical in shape. In the case of the cubes, the square shape of each face is distorted by the phenomenon of the convergence of receding parallel lines. This feature of projection in depth is even more pronounced in the line drawings of the cubes than in the photographs. The shading and texture of the photographic medium give an overall realistic impression while in the line drawings these cues are abstracted, as it were, and presented in essence. The results of the experiment show that the photographs were understood more frequently than the line drawings. For example, nine respondents who correctly identified the photograph of a single cube later said the line drawing of a cube contained three blocks.

According to Piaget and Inhelder, an essential aspect of spatial understanding is motor activity. To be properly understood, an object is not simply perceived. Our understanding also includes internalized movements which anticipate the result of rotating the object or viewing it from a different position. Direct perceptions and potential perceptions constitute an organized whole. An understanding of the plate or the cube seen in perspective or the foreshortened leg implies the interposition of movements that would allow us to see the plate and the cube from directly above, or see the bent upper portion of the leg. In this way passive perception is supplemented by perceptual activity, which involves mental comparisons, transpositions and anticipations.

The distinction between passive perception and perceptual activity may help to explain the differences in performance in these experiments as well as the different interpretations of picture perception advanced by Kennedy and Gregory. Passive perception appears to be adequate for making topological distinctions. Topological shapes may be stretched or bent, but essentially they are invariant. What is important is that all of the elements be present. An elephant should have a trunk, a tail, four legs, two tusks, two ears, and so forth. A pencil should have a point, a shaft, an eraser (if there is one), etc. Stage II respondents, who are pre-operational, are perfectly capable of grasping topological distinctions. This is also a period that is characterized by "intellectual realism" in drawings. Often children's paintings and primitive art contain a medley of viewpoints and impossible juxtapositions of perspectives. Deregowski found that Zambian subjects preferred a split-representational style to a more realistic perspective rendering (see Figure 131).[3] All of

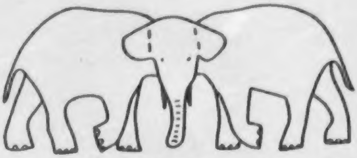

FIGURE 131

Split-representational style
(Source: Deregowski, "A Note on the Possible Determinant . . .," p. 23.)

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[3] J.B. Deregowski, "A Note on the Possible Determinant of Split-Representation as an Artistic Style," International Journal of Psychology, 5, 1970, pp. 21-26.

the known elements are present in the split-representational style. If pictures are considered only from a topological point of view, odd angles will not greatly hinder the perception of content. Thus the baby and the bananas were identified by all the respondents save one in spite of the unusual angles of view. The principles of perspective need not be understood in order to make sense of these shapes. Similarly, in the case of the cartoon figures, all of the essential elements are present, even though distorted. This is not the case, however, with perspective views that result in foreshortening. Under these circumstances the section formed by the nearer parts of the object occlude other parts. To envision that a man's leg is bent or to anticipate that an elliptical shape would appear round if slightly rotated requires perceptual activity.

The experiment by Hochberg and Brooks and the thesis advanced by Kennedy involve only direct perception. Passive registration appears to be sufficient for the recognition of familiar shapes in pictures. Gregory argues that pictures are ambiguous because any two-dimensional image could represent an infinity of possible three-dimensional shapes. This could only apply, however, to those aspects of the shape that are rendered in depth. A coin only begins to look like an ellipse and then like a slit as it is viewed from increasingly oblique angles, not if it is seen from head on. Therefore, it is in regard to the depiction of depth in pictures that shapes become ambiguous and require "active selection" on the part of the viewer. The illusions that Gregory cites in support of his "constructive" theory of picture perception, such as the Ames distorted room or

Rubin's figure-ground reversal drawings, are ambiguous precisely in their depth information and therefore require interpretation in terms of whatever cues the mind is able to grasp.

Picture perception, then, is neither a completely passive process nor an entirely active one. Certain aspects require each mode of perception. Passive registration appears to be sufficient for the instantaneous recognition of familiar shapes in the manner described by Gestalt psychologists. Thus a nineteen month old child could identify an outline drawing of a shoe without previous exposure to pictures. Perceptual activity and the conscious understanding of perspective cues, however, seem to be required for understanding depth in pictures or for interpreting objects where some of the essential parts are masked because of the angle of view. Leach found different levels of understanding with regard to pictorial space. Such differences would quite naturally result from each subject's level of understanding of projective space and his ability to apply this understanding to pictorial cues through the process of perceptual activity. For this reason it is important to study the level of spatial understanding which village people bring to bear on the interpretation of pictorial material.

The Development of Spatial Abilities

Piaget's methods for discovering the development of spatial understanding are highly suited for cross-cultural work. The methods are simple, they can be easily adapted to village conditions, they do not require literacy or any other formal skills, and they employ objects that are familiar in almost all cultural settings, such as a pencil, a coin, or a jar of liquid.

In Experiment 4, drawing geometrical shapes, we saw that the understanding of shape was not simply a matter of perception, but involved mental actions which would reconstruct the object in terms of its spatial relationships. According to Piaget, drawing involves all of the movements, comparisons and anticipations that comprise perceptual activity. When we try to draw an object, we can only depict those aspects that our minds are able to appreciate. The experiment revealed that topological relationships were understood by even the poorest respondents, but euclidean distinctions were often ignored. While the engineering students and the workers in the furniture factory performed at levels close to Stage IIIB, the entire village sample averaged just under Stage IIB+, a pre-operational level.

These findings were confirmed by Experiment 8, the test of horizontality. This experiment, which involved estimating the position of a quantity of liquid in a jar tipped in various directions, revealed the subject's understanding of the natural frames of reference provided by the physical world. In order to successfully estimate the orientation of the liquid surface, the subject had to free himself from relating his predictions to the edges of the container and find a reference point outside, such as the surface of the table. What was surprising in this set of experiments was that subjects in Stage II were unable to derive any insight from being shown the level of the liquid. Their cognitive structures were such that they could not grasp the evidence and apply it to succeeding predictions. In this experiment the village sample performed at an average level approximately midway between Stages IIB+ and IIIA. According to Piaget and Inhelder a frame of reference is not the starting point of spatial awareness but its culmination. It involves the development of a coordinated system of reference which is not part of the mechanism of perception but of intelligence itself. Such a coordinate system is necessary for understanding maps, diagrams, scale reductions, proportion and orientation. By observing the way the village subjects interpreted the evidence which was shown to them during this experiment, it was possible to analyze the cognitive structures by which they record what they see. The evidence indicated that the ability to evaluate perceptual data in an organized manner was only partly developed.

Experiment 11, drawing perspective views of a pencil and a coin, required that the subject be aware that his point of view was only one of many possible points of view. Without this awareness, the observer attributes to objects a kind of pseudo constancy. The jumbled perspectives typical of "intellectual realist" art are an indication that perspective relationships are not coordinated into a coherent system. This experiment proved to be one of the most difficult for the village subjects. Their average overall performance was slightly above the Stage IIB level. The illustrations in the experiment show that the failure to correctly render the perspective views was not due to an inability to draw, but rather to an inadequate understanding of perspective relationships.

Finally, in Experiment 16, coordinating perspectives, subjects were required to locate three objects relative to one another from various points of view. The experiment utilized photographs of a scene taken from various positions and, shown a position, the subject was required to select the appropriate picture. Looking at the pictures alone would not yield the correct answer. The subject had to understand that the relationships of left and right, and before and behind, are not absolute, but relative to a particular point of view. This necessitates a global construct in which all possible points of view are anticipated and coordinated. The experiment was given only to the engineering students. Although the group performed fairly well on the experiment, one third was nevertheless rated at various levels of Stage II and all of them had difficulty at one time or another.

The series of Piagetian tests indicated quite clearly that all of these subjects, and especially the village respondents, had difficulty organizing and coordinating euclidean and projective relationships. As Piaget points out, this process of organization is not part of perception but belongs to the realm of cognition. The evidence of these experiments provides the basis for an explanation of some of the difficulties village people have when interpreting spatial relationships in pictures.

Understanding Pictorial Space

Two of the experiments used exclusively topological cues, and several of the others included topological relationships. The experiment which asked the subject to distinguish between true and false knots (Experiment 6) was correctly solved by 76% of the village subjects. Of the ten respondents making errors, only one missed more than one out of five of the pictures. The test is by no means a question of simple perception. As Piaget and Inhelder point out, each picture is an image of potential actions which can be performed on the shape and involves a great many internalized movements on the part of the observer. The high rate of success in this experiment shows that village subjects are quite capable of coordinating mental actions with regard to topological relationships. This finding is further corroborated by the high rate of correct interpretations of the picture of the man cutting the limb of a tree (Experiment 5). Of the village subjects who were able to identify the pictured objects, 89% were also able to interpret the implied sequence of action. The cues in this picture are again topological ones--order and continuity.

Experiment 7, arranging a series of pictures in a logical sequence, also required an understanding of order. Ninety percent of the village respondents arranged the pictures in an acceptable sequence. Each picture is a frozen moment in a flow of action. This particular abstraction did not appear to cause any difficulty. Conceptually the idea of a sequence of pictures to illustrate steps in an activity seems to be well within the understanding of these subjects. The experiment revealed, however, that there were other, technical aspects of this pictorial convention that could cause failure in communication. Almost half of those who were asked said that the pictures showed different women, and a majority of those who arranged the pictures in order to show the sequence of action made configurations other than a horizontal line reading left to right.

One experiment tested the understanding of euclidean relationships in pictures. This was Experiment 10 on depicted orientation. Here the level of performance was dramatically inferior. Subjects were asked to arrange a set of model animals in the configuration shown in a photograph. While 79% of the village subjects were able to correctly make the topolotical distinctions in the picture (arranging the models in the correct order) only 21% were able to reproduce the correct orientation of the series. Even in the case of the engineering students, only half were able to render the euclidean relationships correctly. Undoubtedly part of the problem had to do with lack of familiarity with pictures. Lack of familiarity, however, did not prevent these subjects from making correct topological distinctions. The Piagetian tests showed that the organization of euclidean space is not fully articulated in most of these respondents. The lack of familiarity may apply not only to the photographic medium but may also, and even more importantly, apply to the understanding of euclidean relationships that these subjects bring to bear on the interpretation of the pictorial cues. If the evidence of seeing the orientation of the surface of a liquid escapes many of them, then the orientation of the model animals to one another and to the picture plane is also not likely to be consciously grasped. The findings of this experiment confirm and perhaps help to explain those of Deregowski's test where Zambian subjects failed to orient a model Landrover with respect to the angle from which it was photographed.

Perceiving depth in pictures is the one problem of pictorial space that has been fairly extensively investigated. One of the experiments used in this series (Experiment 15) replicated to some extent the method used by Hudson in South Africa. Several important modifications, however, were also introduced. Only photographs of models were used so as to avoid arbitrary lines, such as a horizon or the contours of hills. An initial picture showed the models in their true proportions. This was included in order to see if the subjects could evaluate the dramatic change in the size of the elephant between this picture and subsequent pictures. Finally the actual models were given to the subject to arrange. This procedure has two purposes. The first was to see the degree of depth which the subject was able to interpret from the pictorial cues and the second was to see if the comparison of the models with the pictures might lead to some trial and error corrections of their first impressions.

The results of the test were similar to Hudson's. In the case of the cue of object size only 8% of the entire sample was able to demonstrate clearly three-dimensional perception. (The rate was probably higher, however, as not every respondent was asked to make a model.) The cue of overlap was more persuasive, evincing three-dimensional responses from 28% of the sample. One cue that Hudson did not use was the elevation of the figure in the background relative to the other two. This cue led to three-dimensional responses from half of the group and was more successful than the cue of overlap. Hudson had found overlap to be the most persuasive cue in his series of pictures, but overlap does not tell how far behind the partially occluded figure is. In the present experiment, fifteen subjects actually rested the hunter's gun against the elephant's tusk or said the tiger was biting the elephant's foot. It was also interesting to note that "meaningfulness" was often a more important cue to interpreting the action than the visual cues, a finding that was also mentioned by Deregowski. A number of two-dimensional perceivers said the hunter was shooting the tiger. They further explained that the bullet would pass through the legs of the elephant.

All of the cues in this series were recorded by a camera, and all therefore derive directly from the ecology of light. But as we have noted, spatial relationships are not understood by the direct perception of objects. Rather they require the coordination of mental actions performed upon them. Optically, an object diminished in size with an increase of distance. However, we compensate for this apparent shrinkage through a process of perceptual size scaling. This mental compensation is learned by the end of the first year of life. It becomes so natural that it is transparent to us. Vygotsky used the example of grammar to illustrate how the child can use words such as "because" spontaneously, but often become confused when asked to use them deliberately. The study of grammar, however, enables the child to have conscious control of concepts that were previously used spontaneously and only intuitively. Apparently object size is a visual cue that these subjects are not consciously aware of and therefore it cannot be applied to the interpretation of pictorial depth.

It is not likely, therefore, that the success of the cue of elevation was due to its being interpreted projectively. This would require the subject to understand the three models as occupying points of a greatly foreshortened triangle extending away from the viewer. All of the evidence points to this not being the case. The constructions themselves showed only a slight three-dimensional separation, with the elephant behind the two other figures, yet still closer to the man than the tiger was. It is more likely that the elevation was understood topologically as a break or a bend in the line connecting the three figures. The displacement of the elephant in depth was not much different from its elevation in height in the picture.

The exercise which involved drawing a cube (Experiment 12) demonstrates quite clearly that without certain specific experiences, such as those enjoyed by the engineering students, village people are at a loss as to how to depict perspective in drawings. This task is, of course, harder than simple recognition of perspective, but Experiment 13, arranging two cubes as shown in photographs, revealed that recognition of perspective relationships is also not a matter of simple perception. An analysis of the errors made in this experiment indicated that the images were interpreted topologically and not in depth. Bruner has suggested in connection with language that if we are not literate in a symbolic medium, many statements in that medium are likely to fall outside our "competence." In such cases we will interpret those statements in terms of what we know. The same can be said in the interpretation of cues of perspective. Even though the cues in these photographs all derive from the ecology of light, two-thirds of the entire sample and almost all of the villagers missed four out of seven pictures. Not being consciously literate in the cues of projective space, they interpreted the pictures in terms of what they knew, which was topological space.

It was mentioned in Chapter II that a number of investigations found unacculturated peoples less susceptible to visual line illusions, such as the Muller-Lyer Illusion, the Ponzo Illusion, and the Sander Parallelogram, than people from Western societies. It is commonly explained that the oblique lines in the illusions are interpreted as projections in depth and hence the illusion effect. The differences in illusion susceptibility have often been explained in terms of the "carpenteredness" of the environment in which the subjects live. A simpler explanation, and one that perhaps bears investigation, is that the unacculturated groups are unfamiliar with cues of depth in pictures and simply see the pictures two-dimensionally. It is not the carpenteredness of the environment that is the critical factor, but lack of awareness of the principles of perspective.

Limitations of the Study

It should be borne in mind that the empirical study was not designed as a true experiment. No treatment was administered to any of the subsamples and the only variable which could be controlled by the experimenter was the selection of respondents by education or occupation. The main subsamples in the study were the village participants, the workers in the furniture factory, and the engineering students. The village subsample was further divided into illiterate and unschooled, partially literate and unschooled, primary school attenders and secondary school attenders. Respondents were selected on the opportunistic basis of who was available and willing to participate. It can therefore be stated with confidence that the group was fairly unrepresentative of Nepali villagers generally and was probably, on the whole, better at interpreting pictures than the average. The design of the study was a simple, quasi-experimental comparison of group means. The groups were constituted on the basis of level of literacy, education, or, in the case of the factory workers, occupation, and were compared in their performance on the tests of spatial understanding and their ability to interpret pictorial cues. One of the weaknesses of the data is that not every test or every item on a test was given to each respondent, so that the results are not always strictly comparable. Furthermore the sample size is often small, thereby limiting to some extent the validity of the findings. Finally, it has been often stated that years of training are required to administer Piaget's tests correctly, using the clinical method. The author had no such training, but he attempted to use the tests in a manner very much like that described by Piaget and Inhelder in their book. The scoring of the Piagetian tests has been amply illustrated so that others may have an opportunity to draw their own conclusions about the spatial abilities of the subjects. Because of these various limitations the analysis has been descriptive rather than statistical.

The schooled villagers generally performed better than those who had never attended school, but the magnitude of their improvement was not great. It is not possible to say whether their superior performance was the result of certain school experiences or whether the school going subjects were simply brighter. One positive finding, however, that can be stated with some degree of certainty is that the village school does not appear to offer sufficient stimulation in the area of spatial understanding to enable subjects such as these to develop the cognitive structures needed to master euclidean and projective relationships. Hudson also found that schooling had little effect on the interpretation of depth in pictures.

The difference in performance between the village sample on the one hand and the factory workers and engineering students on the other, was much more pronounced. One factor that could account for the difference is acculturation, but the fact that the engineering students, who performed at the highest level of any group, had only been in Kathmandu for about two years, while the factory workers had lived there all their lives, tends to lessen the plausibility of this hypothesis. More likely specific training, especially in projective drawing, accounts for the superior abilities of the engineering students, and the spatial skills required for carpentry work probably account for the differences between the villagers and the factory workers.

Designing Visuals for Use in Villages

We may now return to the subject of coding and decoding visual messages for use in rural development work. Perhaps the single most important finding of this study has been that topological relationships, such as proximity, separation, order, enclosure and continuity are fairly easily understood by unsophisticated picture perceivers, whereas euclidean and projective relationships are not. The implication of this finding is that the use of pictures where important meaning is carried by projective cues should be avoided. Zimmer and Zimmer tell the story of an agricultural agent who drew a perspective picture showing how to transplant coffee trees. When he returned he found the farmers had duplicated his picture exactly. The rows far away were short and planted close together. The nearer rows were successively longer and the trees were planted further apart.[4]

Figure 132 shows a poster designed to illustrate a problem of unsafe drinking water. The picture contains information that is both topological and projective. Among the projective cues are object size (the man, the cow, the houses and the woman walking away from the picture plane are all relatively small); elevation (the stream begins in the upper portion of the picture and descends to the foreground); and perspective in depth (the path becomes narrower as it nears the horizon). Analyzing the message of the picture, however, we see that none of these cues are essential to its meaning. So long as the observer is able to recognize the essential feature of the poster, which is the water, he should be able to grasp the meaning by attending only to the topological relationships. The important topological cue is that there is one body of water and the cow urine, the human excrement and the dirty wash water are all going into it, while at the same time the woman is fetching water from the very same source for drinking. All of the important actions of the picture are connected through the principle of enclosure. The pollutants and the water for drinking are all located in the same two-dimensional surrounding. A sophisticated picture perceiver would note that the man and the cow are upstream and

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[4] Anne Zimmer and Fred Zimmer, Visual Literacy in Communication: Designing for Development (Amersham, England: Hulton Educational Publications, Ltd., 1973), p. 15.

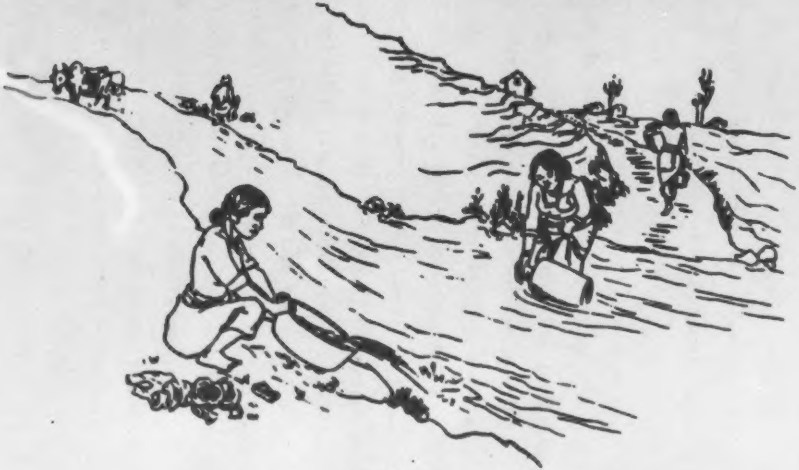

FIGURE 132

An example of a poster where important meaning is communicated through topological cues. (Source: Centre for Educational Research, Innovation and Development, National Education Committee, Kathmandu, Nepal.)

the pollutants produced by them are more likely to enter the woman's jug than the dirty wash water. This level of analysis, however, is not necessary to grasp the meaning of the picture. The simple topological relationship of enclosure ties all of the elements together so that the important connection between the depicted objects and the intended message can be made.

Figure 133, on the other hand, shows a poster where important meaning is conveyed primarily through projective cues. The intent of this picture is to demonstrate good environmental sanitation. The women who are washing and throwing garbage in a pit, another woman who is sweeping, and the man and baby playing on a mat are all fairly clear, and ignorance of the perspective information will not detract from the intended message. This is not the case, however, with regard to the pit latrine and the cow shed. One of the main intentions of the poster is to show that the pit latrine should be built behind the house, away from other activities and that the cow shed should be placed quite far from the house so as not to attract flies. The pit latrine is behind the house in projective space and the cow shed is farther still. In topological space, however, they are right next to one another. Here is an example of an important message that has been encoded with projective cues and therefore runs a high risk of being misinterpreted.

A number of other conclusions can also be drawn from the evidence of these experiments, much of it confirming the findings of other researchers. Foreshortened objects, for example, might appear defective or incomplete to villagers whose own mental images belong to the

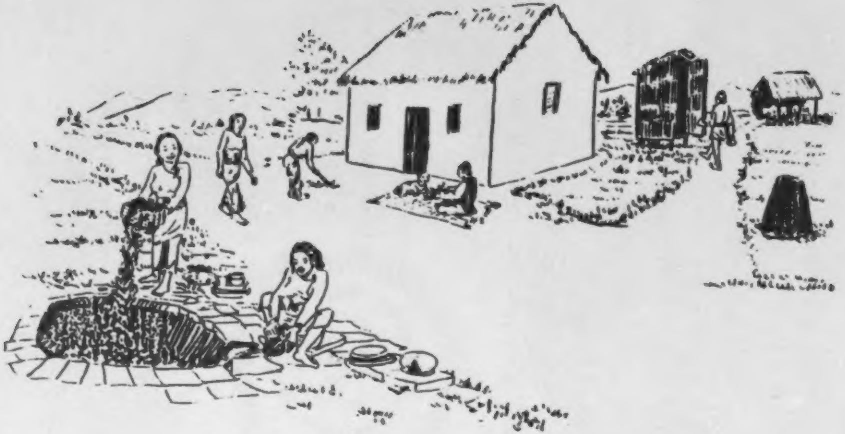

FIGURE 133

An example of a poster which uses projective cues to convey important messages. (Source: Centre for Educational Research, Innovation and Development, National Education Committee, Kathmandu, Nepal.)

stage of intellectual realism. All of the limbs or features should be present to assure proper identification. This may mean a sacrifice of realistic perspective, but the loss of realism will probably go entirely unnoticed. If figures and objects are familiar and clearly drawn, however, recognition does not seem to be a skill that requires specific training. The evidence also indicates that without a better grasp of spatial relationships villagers will simply not be able to absorb a great deal of technical information through pictures. Maps, blueprints, construction diagrams and information in depth will not stand much of a chance of being accurately interpreted. Sequences of pictures are also likely to be misread unless someone is there to explain the order of the pictures. Finally, the importance of pre-testing pictures with the intended audience cannot be overstated. Many errors of communication can be avoided if a few people similar to those the pictures are designed to reach are asked to describe what they see in the picture and what they understand its message to be.

The evidence suggests two possible strategies for aiding village people to increase their pictorial literacy. One strategy involves direct teaching and the other might be characterized as inductive learning. We have mentioned Vygotsky's thesis that one of the primary contributions of learning in school is the awareness and deliberate control we gain with regard to concepts that were previously understood only at an intuitive level. There is strong evidence that cues of perspective can be taught. The dramatic improvement in the performance of the engineering students, who were themselves recruited from the villages only two years previously, shows that certain specific experiences can have a lasting impact on the ability to interpret perspective cues. The teaching experiments by Duncan, Gourlay and Hudson and by Dawson mentioned in Chapter II, where subjects drew scenes in washable paint on a portable glass frame, demonstrated that a few weeks of training in cues of depth could produce significant enduring improvement in pictorial depth interpretation. Other experiments could also be developed to teach perspective cues. For example, in the experiment which involved arranging cubes, if the faces of the cubes were painted different colors and the pictures were similarly color coded, the respondents would have supplementary information to aid them in interpreting the pictures in depth. These and other such teaching experiments would be well worth investigating.

Cues such as object size, the convergence of receding parallel lines, and foreshortened perspectives are encountered every day in the real world of objects and are understood at the level of passive perception. The objective of the teaching exercises would be to help the subject become consciously aware of these cues and to apply them deliberately to the interpretation of pictures. Piaget points out, however, that the organization of spatial relationships and the construction of a coordinated reference system that will link all possible points of view is not something that can be taught. It must be built up in the individual's mind through a gradual process of internalizing actions. Therefore the kinds of spatial relationships that can be directly taught are limited.

The performance of the engineering students on the test of arranging cubes was significantly better than that of the village sample.

It was also seen that they were aware of how to draw three-dimensional shapes such as cubes, a skill they had learned as part of their classwork. This specific drawing experience was of use in interpreting the perspective information in the pictures of cubes. Furthermore, in the experiment on pictorial depth perception the only subjects who indicated that the elephant was more distant from the man than the tiger was were three of the engineering students. Certain experiences had also led them to a more accurate comprehension of the cue of object size. At the same time seven of the engineering students, although interpreting the scene in depth, were not able to reproduce the spatial relationships of the scene correctly. Also half of the engineering students could not reproduce the euclidean relationships depicted in the photograph of the model animals in Experiment 10. It can be seen, therefore, that it may be possible to teach certain specific pictorial cues, but an accurate comprehension of all spatial relationships in pictures depends upon the development of more fundamental cognitive structures.

The tasks that the engineering students had difficulty with were the ones where, in Goodnow's words, the subject has to "transform an event in his head, has to shift or shuffle things around by some kind of visualizing or imaging rather than by carrying out an overt series of changes." Goodnow went on to say as we mentioned in Chapter III,

> It used to be thought that "disadvantaged" groups would be most handicapped on verbal or abstractive tasks and that imaging or spatial-type tasks would be the fairest. This seems not to be so. . . .

The evidence of these experiments seems to confirm Goodnow's statement. The mental transformations and shufflings she describes appear to be the same kinds of coordinations and comparisons that Piaget mentions with regard to spatial understanding at the level of representation.

In the West we receive very little direct training in picture perception. Mostly we learn pictorial literacy by inductive methods. We are exposed to many examples of pictorial cues in different contexts and we gradually learn to interpret them correctly. Village people, however, see relatively few pictures and have little opportunity for learning of this kind. We have discussed Bruner's thesis that language, literacy and pictures, among other media, can provide learning through symbolically coded experiences. Symbolic learning, however, requires literacy in the particular symbol system being used. In technically less developed societies, children learn by doing (enactive learning) and by modeling (iconic learning) more than they do through any overt instruction (symbolic learning). Bruner believes, however, that cognitive development depends to a great extent on the intellectual demands made by society and the extent to which each individual has opportunities and is encouraged to explore these three modes of knowing. Since pictures are not one of the traditional symbol systems of most village cultures, it stands to reason that people may at first have difficulty getting much meaning from pictorially coded instruction. Pictures can, however, and should be introduced as a supplement to verbal instruction. Pictures can be used to code particular problems or states of being and in the manner that Freire uses pictures for consciousness raising literacy instruction, pictures can be introduced to stimulate discussion and dialogue.[5]

This method has two advantages. In the first place the pictures are not required to stand on their own. They are used as teaching aids and the extension agent or facilitator can discuss the pictorial content and its meaning with the village participants. Therefore the message will be at first primarily carried by the more traditional and familiar method of verbal explanation. The second advantage of this method is that village people will be gradually exposed to the symbol system of pictorially coded messages. If a conscious effort is made to introduce pictures to a village setting, and those pictures are not merely looked at but examined and discussed, it is likely that inductive learning will take place. Gradually through a process of repeated examples in differing contexts, certain pictorial cues will be consciously grasped and applied. Eventually the pictures themselves may be able to carry the burden of certain messages. Just as in literacy training, where the symbols are introduced in a rational and sequential manner, pictorial cues could be consciously and systematically introduced and reinforced in a series of lessons.

At first topological cues such as proximity, separation, order or surrounding would be used to carry the messages. Projective relationships would be gradually introduced in non-essential details. Eventually, however, they would be given increasing importance. Manipulating real objects or models and arranging them as shown in pictures could be effective group exercises, where the participants would discuss the visual cues and point them out to one another. Participants could make maps for one another, showing where something is hidden. A game such as this might give them a better understanding of euclidean space. Methods such as these need to be tried and evaluated as part of village education programs, whether formal or nonformal. There are probably no shortcuts to acquiring literacy in pictorial cues, only methods that are more or less effective. Finding the methods that work will greatly increase the usefulness of pictures as a means of communication in the development of human resources.

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[5] See Paulo Freire, Pedagogy of the Oppressed (New York: Herder and Herder, 1972).

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APPENDIX

PICTURE PERCEPTION QUESTIONNAIRE

Number: ____

Date: ______________________

Place: ____

Biographical Data

Name: ____

tapāin̲ko subha nām ke ho? (What's your name?)

Sex: M___ F___

Age: ______________________

tapāin̲ kati barsako hunu bhayo? (How old are you?)

Caste or ethnic group: ______________________________________

Education:

Schooling: Yes___ No___

tapāin̲ skulmā paṛhnu bhaeko chha? (Have you studied in school?)

Number of years: _____

kati barsa paṛhnu bho? (How many years have you studied?)

Up to what class: _____

kati klās samma paṛhnu bho? (Up to what class did you study?)

Literacy:

Literate: Yes___ Partially___ No___

lekhā-paṛhi garna saknu hunchha? (Do you know how to read and write?)

Demonstration:

to parhna saknu hunchha? (Can you read this?)

____ cannot read

____ can make out a few words

____ reads haltingly

____ reads easily

Work: ____

tapāin ke kām garnu hunchha? (What work do you do?)

1. Identification of Photographs (Experiment 1)

ma sita kehi tasbirharu chhan. yo tasbirmā ke dekhnu hunchha?
(I have some pictures with me. What do you see in this picture?)

1. ghar ___ (house)   kerāko ghāri ___ (banana plants)   jhandā ___ (flag)

   yo gharko mānchhele kun dharma manchhan? ____________________
   (What religion do the people in this house follow?)

2. āimāi ___ (woman)   nānglo ___ (sifting basket)

   yo āimāile ke gardai chhin? kelāeko _____
   (What is this woman doing?) (Sifting)

3. bhainsiko pāṛo ___
   (buffalo calf)

4. chiya banaeko ___ (making tea)   gilans ___ (glass)   kitli ___ (kettle)   birko ___ (lid)

   chiyako baṭṭā ___ (tea packet)   chimta ___ (tongs)   chamcha ___ (spoon)   thāl ___ (plate)

5. bachchā ___
   (baby)

6. khorsani ___
   (peppers)

7. thāl ___
(plate)

8. kāmi ___ hansiya banāeko ___
(blacksmith) (making a sickle)

9. kerāko boṭh ___
(banana plant)

10. kodālo ___
(hoe)

11. doko banāeko ___
(making a basket)

12. bhainsi ___ hāns ___ pānimā paudi kheleko ___
(buffalo) (ducks) (swimming in the water)

13. makai ___
(corn)

14. keṭo ___ changā urāeko ___
(boy) (flying a kite)

15. challā ___
(chicks)

katiota challā dekhnu hunchha? ___
(How many chicks do you see?)

2. Copying Geometrical Shapes (Experiment 4)

tapāinle kahilyai naksā banāuna bhaeko thiyo?
(Have you ever drawn a picture?)

yo naksā hernos. yo kāgajmā yastai banāunos.
(Look at this picture. Draw one just like this on this piece of paper.)
(Attach drawing)

3. Drawing a Cube (Experiment 12)

yasko ākār banāuna saknu hunchha? ___
(Can you draw the shape of this?)

tapāin̲le jasto dekhnu hunchha, tyastai banāunos.
(Draw it just as you see it.)
(Attach drawing)

4. Identifying Pictures of Model Animals (Experiment 2)

yi janāwarharulāi hernos. yaska nāmharu bhanna saknu huncha?
(Look at these animals. Can you tell me their names?)

yi janāwarharu madhye, tasbirmā dekhāeko kun chāhin̲ ho?
(Which of these animals is shown in the picture?)

1. gai (drawing) ___
(cow)
2. bhen̲ṛa (photograph) ___
(sheep)
3. sun̲gur (cartoon) ___
(pig)
4. bachho (d) ___
(calf)
5. bāgh (p) ___
(tiger)
6. ghoṛā (c) ___
(horse)
7. hātti (d) ___
(elephant)
8. gadhā (p) ___
(donkey)
9. bhen̲ṛa (c) ___
10. ghoṛā (d) ___
11. sun̲gur (p) ___
12. bāgh (c) ___
13. goru (d) ___
(bull)
14. suteko ghoṛā (p) ___
(sitting horse)
15. hātti (c) ___
16. bāchho (p) ___
17. gadhā (d) ___
18. gāi (c) ___
19. ghoṛā (p) ___
20. suteko ghoṛā (d) ___

5. Arranging Model Animals in Pictured Order (Experiment 10)

yi janāwarharulāi tasbirmā jastai milāunos.
(Arrange these animals just as in the picture.)

Correct order ___

Correct orientation of animals ___

Oblique line ___

6. Foreshortening (Experiment 14)

yo tasbirmā ke dekhnu hunchha?
(What do you see in this picture?)

euṭā khuṭṭa kina chhoṭo dekhinchha?
(Why does one foot look short?)

Sees no problem with the picture ___

7. Knots (Experiment 6)

maile yo ḍori yasari tāne bhane, gānṭho parchha.
(If I pull this string like this, it will make a knot.)

tara yasari tāne bhane gānṭho pardaina. yo tasbir hernos.
(But if I pull it like this it won't. Look at this picture.)

yo doriko dui bhāg tānyo bhane, gānṭho parchha ki pardaina?
(If I pull the two ends of this string, will it make a knot or not?)

a. K ___

b. x ___

c. x ___

d. K ___

e. x ___

8. Seeing Potential Action in Pictures (Experiment 5)

yo chitramā ke kurā dekhnu hunchha?
(What do you see in this picture?)

mānis ___	rukh ___	hansiya ___	hānga kateko ___
(man)	(tree)	(sickle)	(cutting a branch)

yo mānisle thik kām gareko chha?
(Is this man doing his work all right?)

hānga katisakepachi ke hunchha?
(What will happen after he has cut the branch?)

Sees nothing wrong with picture ___

upani hānga sangai tala jhardachha ___
(He'll fall down with the branch.)

9. Arranging a Series of Pictures in Order (Experiment 7)

ke dekhnu hunchha?
(What do you see?)

tasbirko swāsnemānchhe eutai ho ki begla beglai ho?
(Is it one woman or different women in the pictures?)

___ same woman

___ different women

yi tasbirharulāi kramai (melai) sanga milāunu saknu hunchha?
(Can you put these pictures in order?)

pahilo tasbir kun chāhin ho?
(Which is the first picture?)

a. gathering b. tying c. kneeling d. walking

Order of arrangement: ___ ___ ___ ___

Pattern of arrangement:

10. Cues of Three Dimensions (Experiment 15)

yo tasbirmā ke ke dekhnu hunchha?
(What do you see in this picture?)

hātti ___	sikāri ___	bāgh ___	banduk ___
(elephant)	(hunter)	(tiger)	(gun)

sikārile ke gardai chha?
(What is the hunter doing?)

sikārile goli hāttilāi hān̲daichha ki bāghlāi hān̲daichha?
(Is the hunter shooting the elephant or the tiger?)

sikāri baseko thāun̲ bāṭa hātti najikai chha ki bāgh najikai chha?
(Which is closer to the hunter, the elephant or the tiger?)

bāghle sikārilāi dekhna sakchha?
(Can the tiger see the hunter?)

Picture #	Man is shooting		Nearer to man		Tiger can see man	
	El.	Ti.	El.	Ti.	Yes	No
1	___	___	___	___	___	___
2	___	___	___	___	___	___
3	___	___	___	___	___	___
4	___	___	___	___	___	___

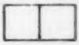
yi namunāharulāi tasbirko jastai milāunu saknu hunchha?
(Arrange these models just as in the picture.)

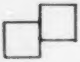
Picture # Pattern of arrangement:

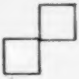
11. Arranging Two Cubes as Shown in Pictures (Experiment 13)

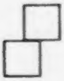
yo tasbirmā katiota kāṭhko ṭukrā dekhnu hunchha?
(How many pieces of wood do you see in this picture?)

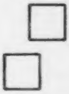
yi tukrālāi liera tasbirmā̃ jastai milāunos.
(Take these pieces and arrange them just as in the picture.)

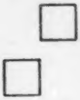
1. 

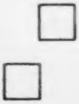
2. 

3. 

4. 

5. 

6. 

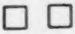
7. 

12. Counting Cubes and Making Constructions (Experiment 3)

yo tasbirko jasto banāuno, katioṭa kāṭhko ṭukrā chahinchha?

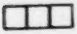
(How many pieces of wood do you need to make what you see in this picture?)

1. two (d) ___



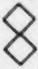
2. one (p) ___

3. three (d) ___

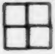


4. one (p) ___

5. two (d) ___

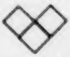


6. four (p) ___

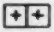


7. one (d) ___

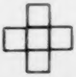
8. three (p) ___



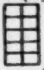
9. four (d) ___



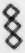
10. five (p) ___



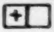
11. ten (d) ___



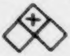
12. three (p) ___



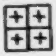
13. three (d) ___



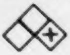
14. four (p) ___



15. eight (d) ___

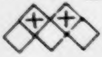


16. four (p) ___

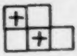


17. six (d) ___

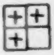
18. seven (p) ___



19. seven (d) ___



20. seven (p) ___



13. Perspective Views of a Pencil and a Coin (Experiment 11)

yo sisākalam hernos. yasko naksā banāuna saknu hunchha?
(Look at this pencil. Can you make a drawing of it?)

yo rām bahādur ho. u tyahān̲ ubhieko chha.
(This is Ram Bahadur. He's standing here.)

rām bahādur baseko thāun bāṭa sisākalam kasto dekhinchha?
(From the place where Ram Bahadur is standing how does the pencil look?)

(Attach drawings)

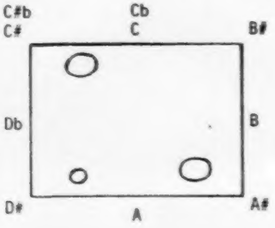
14. Coordination of Perspectives (Experiment 16)

yi namunāharulāi liera, tasbirko jastai milāunos.
(Take these models and arrange them just as in the picture.)

rām bahādur yahān̲ ubhiraheko chha. u ubhieko thāun̲ bāṭa
(Ram Bahadur is standing here. From the place where he is standing,

yo drishya kasto dekhinchha? yi tasbirharu madhye bāṭa pattā
how does this scene look? Can you find it among these

lagāunu saknu hunchha?
pictures?)



C ___

B# ___

A# ___

C# ___

B ___

D ___

15. Reproducing a Layout (Experiment 9)

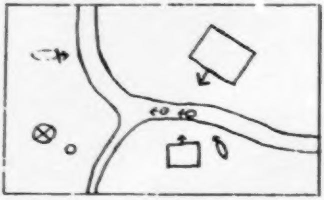
māne linos. yo euṭā pahāḍko naksā ho. yo mul bāṭo ho.
(Imagine. This is a map of a Hill scene. This is a main road.)

mul bāṭo dekhi euṭā sāno bāṭo gaeko chha. euṭā ṭhulo ghar
(A small path goes off here. Here is a large house.)

yahān̲ chha. (goth, thulo rukh, sano rukh, gāi, bhen̲ṛa, hān̲s)
(shed, big tree, small tree, cow, sheep, duck)

yahān̲ arko pahāḍko naksā chha.
(Here is another Hill map.)

yi kurāharu liera mero jastai euṭā gāun̲ banāunos.
(Take these things and make a village just like mine.)

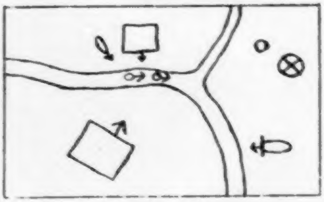


Correct placement ___

Correct orientation ___

Correct distances ___

aba ma yo naksā ulto parchhu. pheri mero jastai banāunos.
(Now I'm going to turn this map around. Now make a village just like mine again.)



Trial and error ___

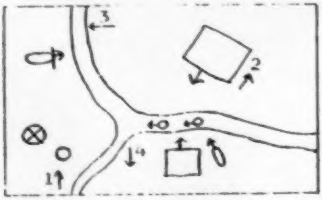
Correct placement ___

Correct orientation ___

Correct distances ___

yo ghoralāi yahān̲ rakhchhu. tapāin̲ko gāun̲mā pani, yehi thāun̲mā,
(I'm putting this horse here. Can you put this horse in this

rakhnu saknu hunchha?
same place in your village?)



Position 1 ___

Position 2 ___

Position 3 ___

Position 4 ___

16. Horizontality (Experiment 8)

yo sisimā chiyā chha. yo, tyo sisko naksā ho.
(There is tea in this jar. This is a picture of the jar.)

sisimā chiyā kahān̲ samma chha yo naksāmā banāunos.
(Draw me where the tea comes to in this picture.)

ahile yo thailimā sisi hālchhu. sisi yasari rākhchhu.
(Now I'm putting the jar in this bag. I'm putting the jar like this.)

ahile sisi yasto dekhinchha, hoina ta?
(Now the jar looks like this, doesn't it?)

aba bichār garnos, chiyā kasto dekhinchha holā? yahān̲ banāunos.
(Now imagine. How do you think the tea looks. Draw it here.)

aba hernos, yo thik chha? thik banāunos.
(Now look. Is it right? Make it right.)

(Attach drawings)